



Laporan Akhir Projek Penyelidikan Jangka Pendek

**Investigation and Modelling of Particulate
Matter During Haze Events in 1997, 2004,
2005**

by

**Assoc. Prof. Dr. Nor Azam Ramli
Assoc. Prof. Dr. Ahmad Shukri Yahaya**

2008

LAPORAN AKHIR PROJEK PENYELIDIKAN JANGKA PENDEK

304.PAWAM. 6035197

INVESTIGATION AND MODELLING OF PARTICULATE MATTER

DURING HAZE EVENTS IN 1997, 2004, 2005.

PROFESOR MADYA DR NOR AZAM RAMLI

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BORANG

LAPORAN AKHIR PROJEK PENYELIDIKAN JANGKA PENDEK
FINAL REPORT OF SHORT TERM RESEARCH PROJECT

Sila kemukakan laporan akhir ini melalui Jawatankuasa Penyelidikan di Pusat
Pengajian dan Dekan/Pengarah/Ketua Jabatan kepada Pejabat Pelantar Penyelidikan

1. Nama Ketua Penyelidik: Profesor Madya Dr Nor Azam Ramli
Name of Research Leader

☒ Profesor Madya/
Assoc. Prof.

☐ Dr./
Dr.

☐ Encik/Puan/Cik
Mr/Mrs/Ms

2. Pusat Tanggungjawab (PTJ):
School/Department

Pusat Pengajian Kejuruteraan Awam

3. Nama Penyelidik Bersama:
Name of Co-Researcher

Profesor Madya Ahmad Shukri Yaiza

4. Tajuk Projek:
Title of Project

Investigation and Modeling of Particulate Matter
During Haze Events in 1997, 2004 and 2005

5. Ringkasan Penilaian/Summary of Assessment:

	Tidak Mencukupi Inadequate		Boleh Diterima Acceptable	Sangat Baik Very Good	
	1	2	3	4	5
i) Pencapaian objektif projek: Achievement of project objectives	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
ii) Kualiti output: Quality of outputs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
iii) Kualiti impak: Quality of impacts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
iv) Pemindahan teknologi/ potensi pengkomersialan Technology transfer/commercialization potential	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
v) Kualiti dan usahasama: Quality and intensity of collaboration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
vi) Penilaian kepentingan secara keseluruhan: Overall assessment of benefits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

6. Abstrak Penyelidikan

(Perlu disediakan di antara 100 - 200 perkataan di dalam **Bahasa Malaysia dan juga Bahasa Inggeris**. Abstrak ini akan dimuatkan dalam Laporan Tahunan Bahagian Penyelidikan & Inovasi sebagai satu cara untuk menyampaikan dapatan projek tuan/puan kepada pihak Universiti & masyarakat luar).

Abstract of Research

(An abstract of between 100 and 200 words must be prepared in Bahasa Malaysia and in English).

This abstract will be included in the Annual Report of the Research and Innovation Section at a later date as a means of presenting the project findings of the researcher/s to the University and the community at large)

Dilampirkan

7. Sila sediakan laporan teknikal lengkap yang menerangkan keseluruhan projek ini.

[Sila gunakan kertas berasingan]

Applicant are required to prepare a Comprehensive Technical Report explaining the project.

(This report must be appended separately)

Dilampirkan

Senaraikan kata kunci yang mencerminkan penyelidikan anda:

List the key words that reflects your research:

Bahasa Malaysia

Bahasa Inggeris

Dilampirkan

8. Output dan Faedah Projek

Output and Benefits of Project

(a) * Penerbitan Jurnal

Publication of Journals

(Sila nyatakan jenis, tajuk, pengarang/editor, tahun terbitan dan di mana telah diterbitkan/diserahkan)

(State type, title, author/editor, publication year and where it has been published/submitted)

Dilampirkan

① 2 kertas kerja telah dihantar ke
Jurnal antarabangsa.

② 6 kertas kerja dalam prosiding
beruasat antarabangsa.

- (b) Faedah-faedah lain seperti perkembangan produk, pengkomersialan produk/pendaftaran paten atau impak kepada dasar dan masyarakat.
State other benefits such as product development, product commercialisation/patent registration or impact on source and society.

Dapatan penyelidikan ini telah menjadi salah satu asas pemuliharaan Pelan Tindakan Udara Bersih Malaysia.

* Sila berikan salinan/Kindly provide copies

- (c) Latihan Sumber Manusia
Training in Human Resources

- i) Pelajar Sarjana: 6 orang
Graduates Students
(Perincikan nama, ijazah dan status)
(Provide names, degrees and status)

- ii) Lain-lain: PhD - 2 orang
Others

9. Peralatan yang Telah Dibeli:
Equipment that has been purchased

Tiada




Tandatangan Penyelidik
Signature of Researcher

3/11/08
PROF. Madya DR. NOR AZAM RAMLI
Pusat Pengajian Kejuruteraan Awam
Kampus Kejuruteraan
Universiti Sains Malaysia

Komen Jawatankuasa Penyelidikan Pusat Pengajian/Pusat
Comments by the Research Committees of Schools/Centres

KPI utk geran jangka pendek melebihi dari
expectation. Output yang baik


PROFESOR DR. HAMIDI ABDUL AZIZ
Pusat Penyelidikan Jangka Pendek
Universiti Kebangsaan Malaysia
TANDATANGAN PENERUSI
JAWATANKUASA PENYELIDIKAN
PUSAT PENGAJIAN/PUSAT
Signature of Chairman
[Research Committee of School/Centre]

8/11/08

Tarikh
Date

ABSTRAK

6. Abstrak

Haze events occurred in Malaysia almost every year since more than two decades. These events were usually accompanied with high PM₁₀ concentrations which can last longer than three days. This study attempt to characterized the years with haze events systematically by fitting the monitoring records into three distributions that were reported to have dealt with extreme events especially those related to air pollutions studies. These distributions plotted were then utilized to established exceedences of Malaysian Air Quality Guidelines and prevalence of high PM₁₀ concentrations. Worst high particulate events were identified in 1997 as compared to 2004 and 2005 in most of the selected study sites. Weather parameters were expected to have some influence on the concentrations of PM₁₀. Previous hour concentrations, wind speed and temperature were proven to have great influence on predicted PM₁₀ concentrations. A workable framework was proposed from this research to reduce the incidents of exceedences which requires close cooperation between multiple levels of governance and enforcements. In addition, efforts on capacity building and specific skill training should be given ample attentions. Finally, education, awareness and willingness to change at all walk of life are paramount in ensuring environment provides better air quality.

LAPORAN TEKNIKAL

7. Laporan Teknikal.

- a. Distributions patterns of PM₁₀ concentrations using probability distribution functions i.e. Weibull distributions, gamma distributions and lognormal distributions were plotted for monitoring records from stations in Seberang Perai, Kuching, Jerantut, Nilai, Indera Mahkota and Kuala Lumpur. Results from descriptive statistics indicated that during years with haze events recorded the means calculated were higher than the medians. The results suggest that there were higher records with PM₁₀ concentrations on the right hand side of the plot. These observations were confirmed by the value of skewness and kurtosis recorded at all sites. Annual means values suggested that 1997 was the worst haze events occurred in Malaysia. Conversely, annual mean for monitoring station in Kuala Lumpur showed descending trend. Further investigation revealed that this observation was mainly due to relocation of monitoring stations from road side to residential area. Jerantut and Indera Mahkota, both, showed ascending trend for PM₁₀ annual means which indicated that pollution for both areas were on the rise. (see LAMPIRAN 1).
- b. Best performance indicator were established for each year and site. Six performance indicators were used in order to identify the 'best' distribution to describe PM₁₀ during year with 'haze events' at different sites. The results confirmed that log normal distribution as the best distribution to represent monitoring records during high particulate events i.e. haze events. (see LAMPIRAN 2).
- c. Exceedences and prevalence period of the PM₁₀ concentration above the Malaysian Air Quality Guidelines for daily average and annual average using the cumulative distribution functions. Seberang Perai recorded the highest exceedences in 2005 at 10.7% of the time compared to other stations which recorded the highest exceedences in 1997. In 2005, the calculated prevalence of exceedences was 39 days with return period of 9 days. Time series plot for each year showed similar results. (see LAMPIRAN 3 and 4)
- d. First order reactions of influence of weather parameters on changing patterns of PM₁₀ concentrations during year with 'haze events' was best represented by the equations:-

$$PM_{10} = -87.316 + 5.419T - 0.034T^2 - 5.058ws + 0.095ws^2 + 0.931PM_{10,t-1}$$

Parameters considered to have biggest influence on the model were temperature, windspeed and previous hour PM₁₀ concentration at $r^2 = 0.9163$. (see LAMPIRAN 5)

- e. Workable framework to minimise the magnitude of the impact of this recurring haze events to general public was drawn which involved inter government, federal government agencies, state government, and all stake holders. More stringent enforcement and tighter cooperation should lead to the expected reductions in the number of haze events, thus, minimizing the impacts of PM₁₀ to the environment. (see LAMPIRAN 6 and 7)

Key word: PM₁₀, haze events, exceedences,
Kata kunci: PM₁₀, keadaan berjerubu, melampau

LAMPIRAN 1

DESCRIPTIVE STATISTICS AND PROBABILITY DISTRIBUTIONS
DESCRIPTIVE STATISTICS (1997)

	Perai	Kuching	Jerantut	Nilai	Indera Mahkota	Kuala Lumpur
Total, N	8482	8076	4324	8466	8309	7922
Minimum	8	3	1	10	8	8
Maximum	718	995	439	631	331	629
Mean	77.70	73.05	40.51	79.18	33.59	116.68
Variance	>1000	>1000	>1000	>1000	882.11	>1000
Std dev	58.96	114.05	51.71	67.03	29.70	67.94
Median	65	41	25.5	59	25	101
Skewness	3.55	4.66	3.97	3.29	3.22	2.20
Kurtosis	24.70	28.53	22.58	18.67	18.58	10.38

PARAMETERS VALUES (1997)

1. GAMMA DISTRIBUTION

	Perai	Kuching	Jerantut	Nilai	Indera Mahkota	Kuala Lumpur
σ (scale)	2.5498	1.1555	1.3123	2.2928	2.1011	3.8426
λ (shape)	30.4715	63.2195	30.8730	34.532	15.989	30.366

2. LOG-NORMAL DISTRIBUTION

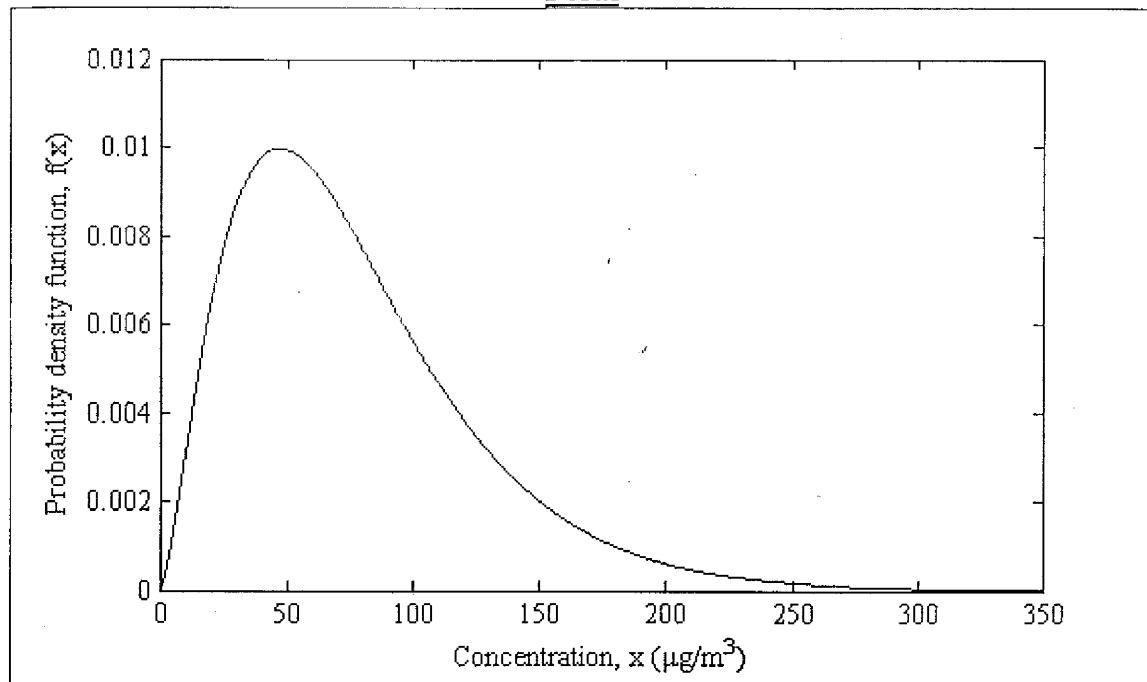
	Perai	Kuching	Jerantut	Nilai	Indera Mahkota	Kuala Lumpur
μ (location)	4.1441	3.7996	3.2745	4.138	3.2579	4.6237
σ (scale)	0.6502	0.8781	0.8699	0.6585	0.6862	0.5152

3. WEIBULL DISTRIBUTION

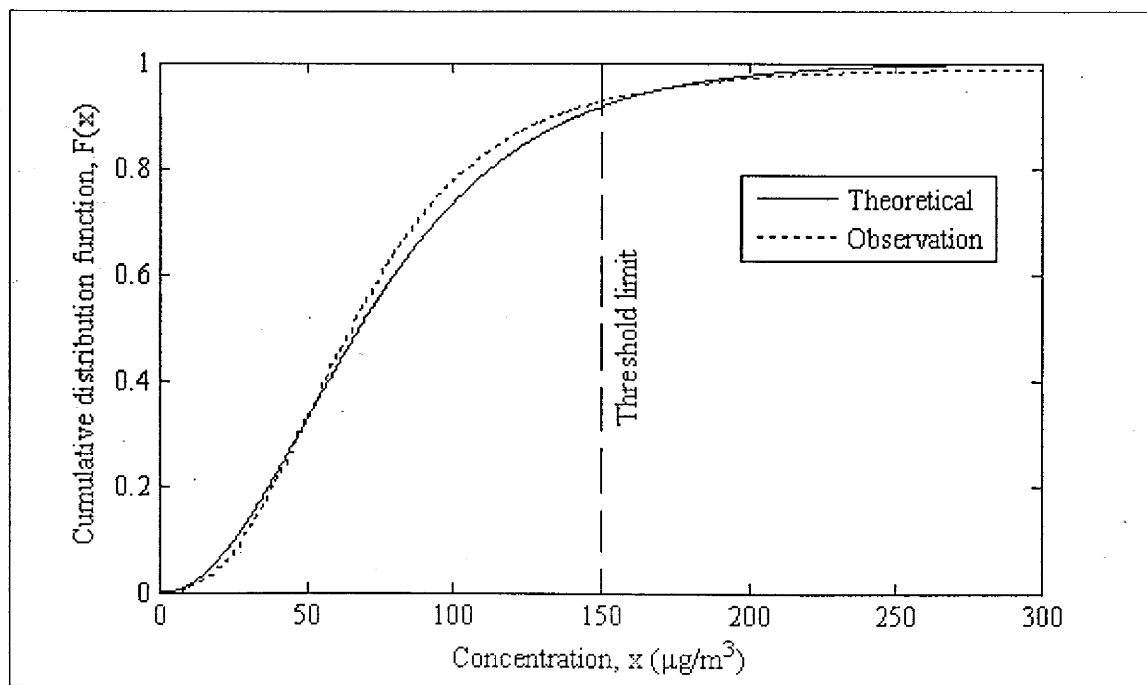
	Perai	Kuching	Jerantut	Nilai	Indera Mahkota	Kuala Lumpur
σ (scale)	86.8648	71.4227	41.4832	87.8978	37.0609	132.1497
λ (shape)	1.5089	0.9622	1.0496	1.4004	1.3482	1.8572

Probability Distribution Functions and Cumulative Distribution Functions for 1997

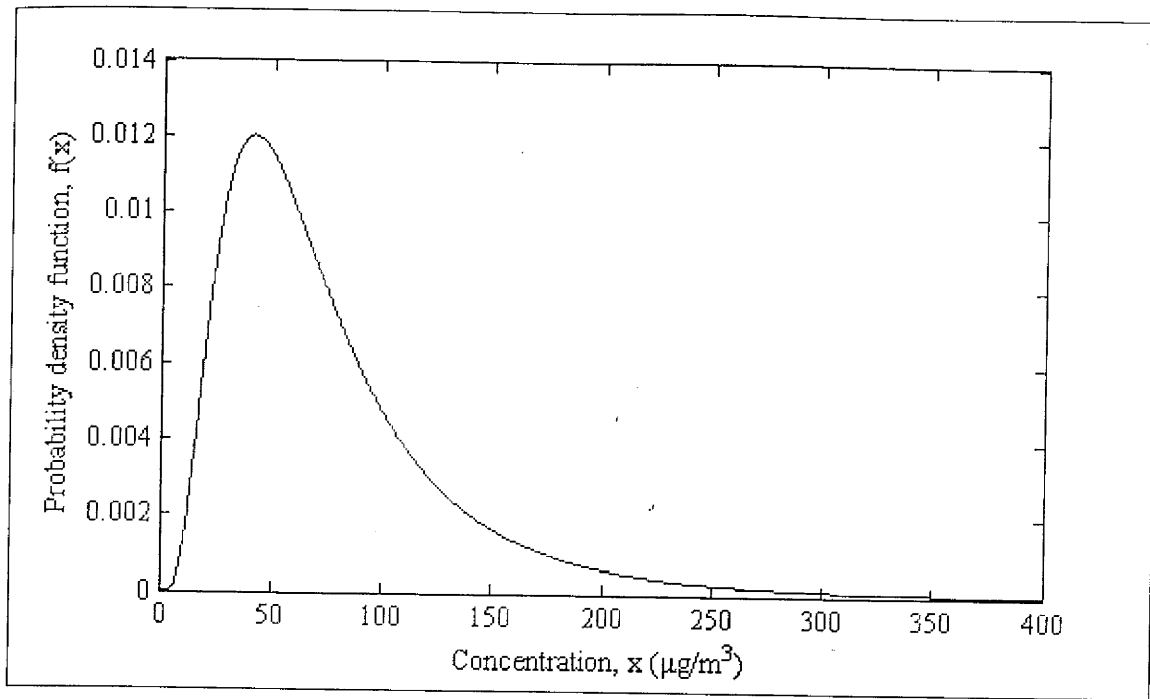
Peraí



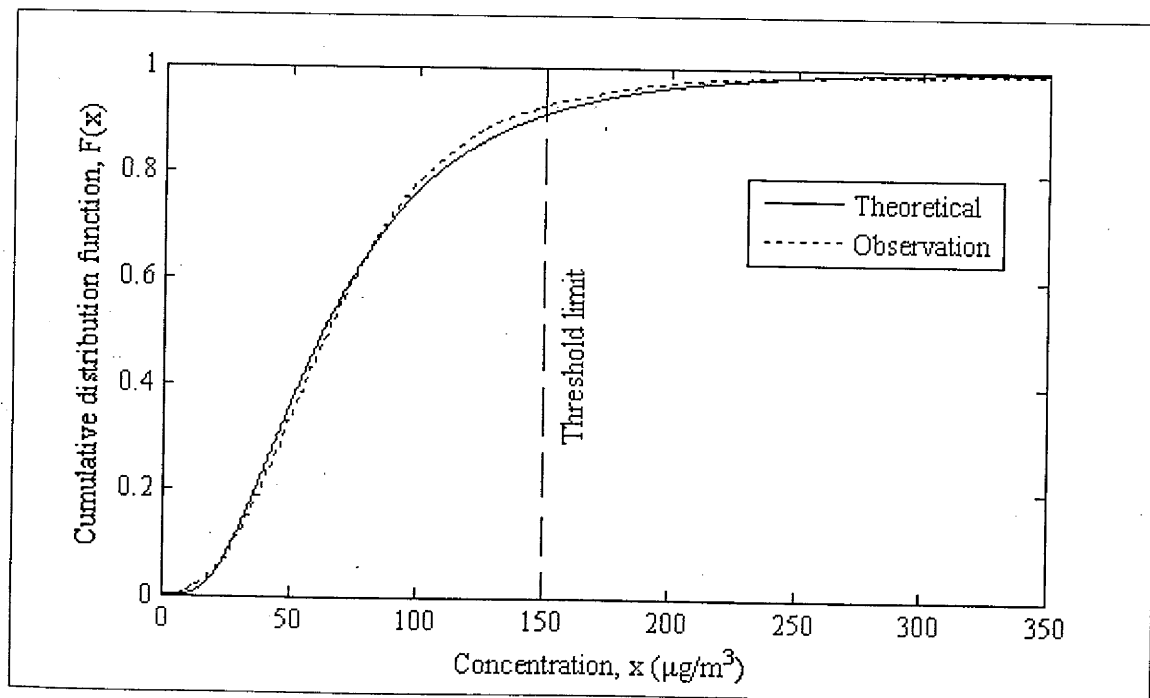
The probability distribution functions using Gamma distribution for Peraí



The cumulative distribution function plot using Gamma distribution for Peraí

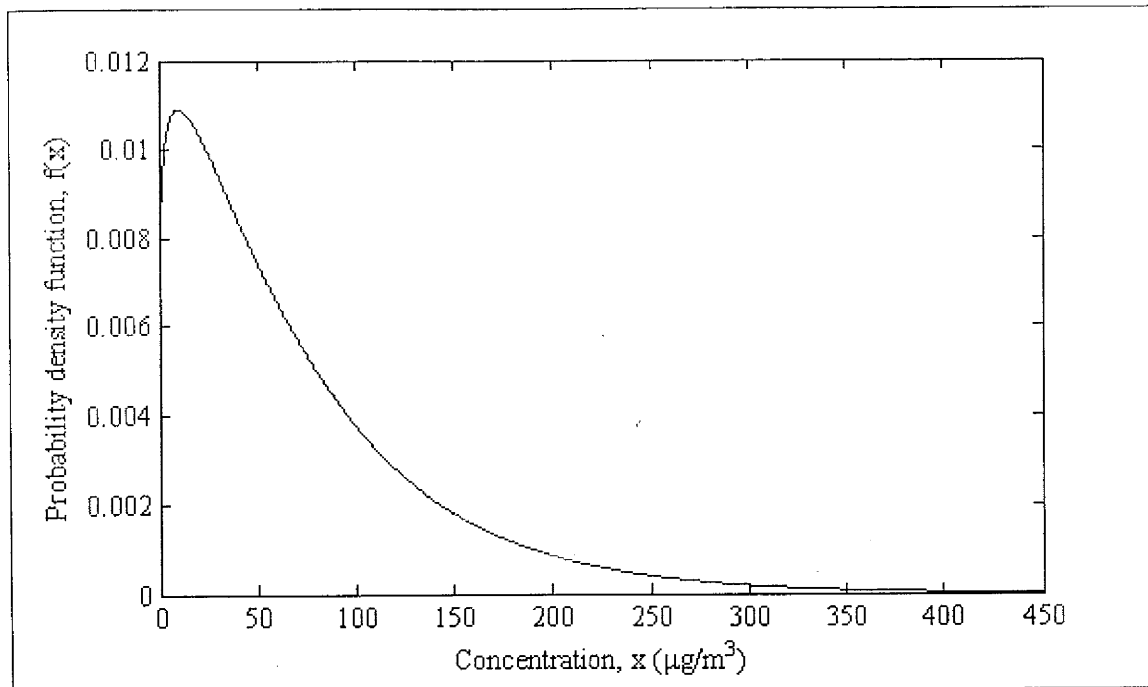


The probability distribution functions using Log-normal distribution for Perai

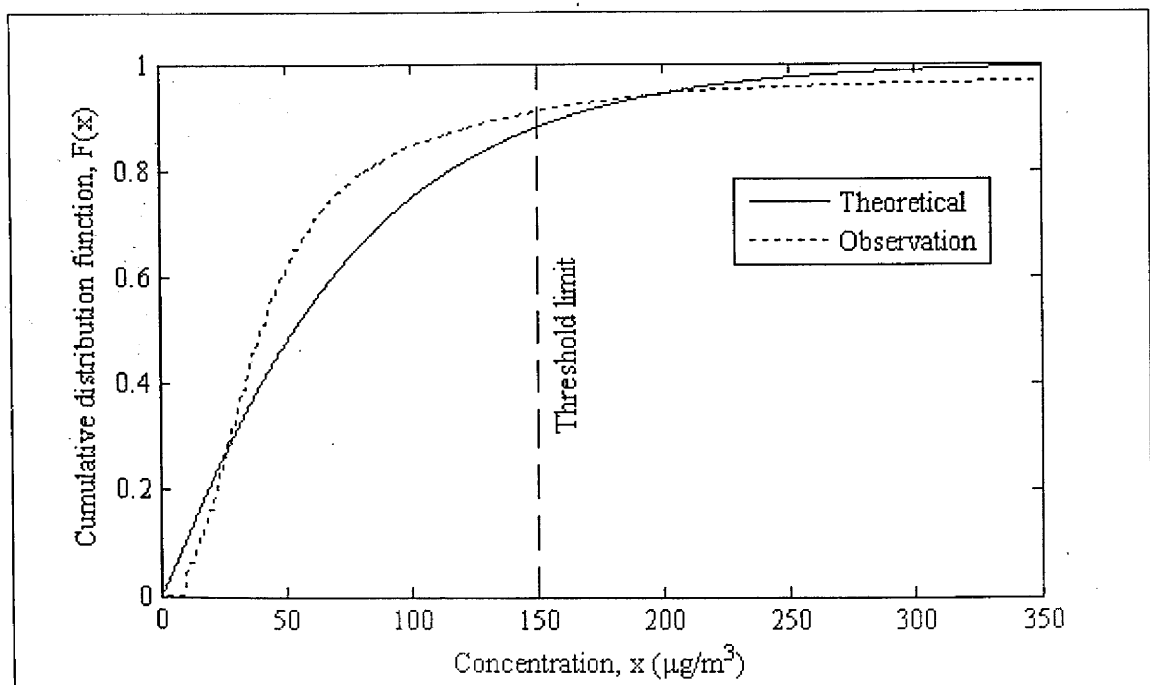


The cumulative distribution function plo. using Log-normal distribution for Perai

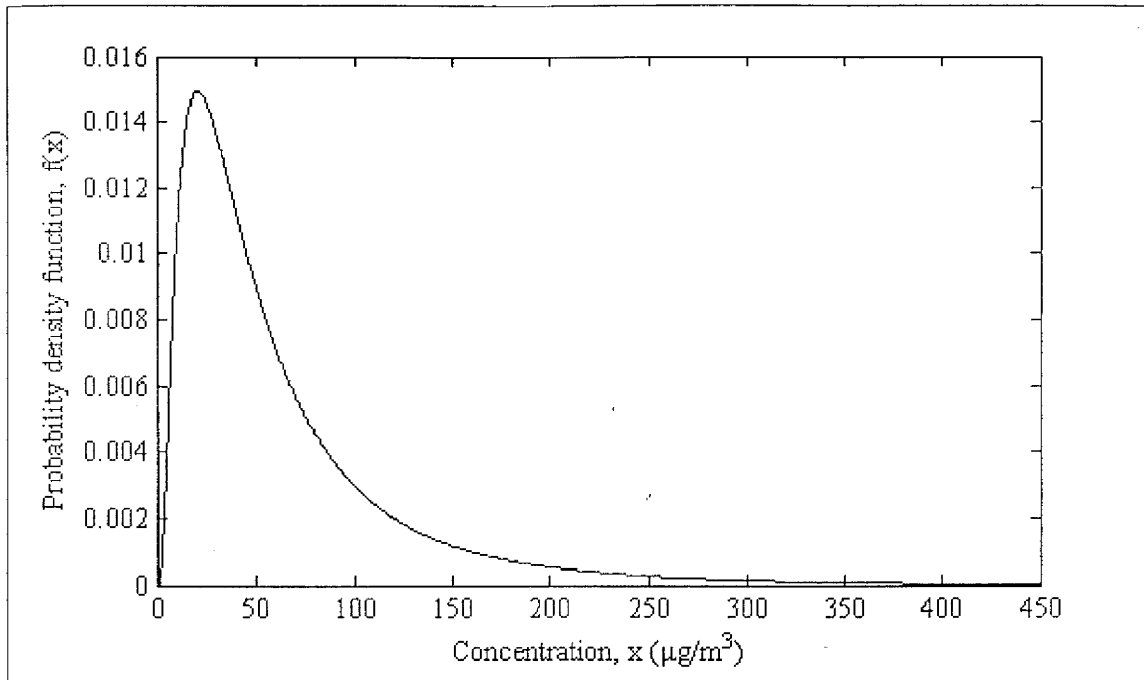
Kuching



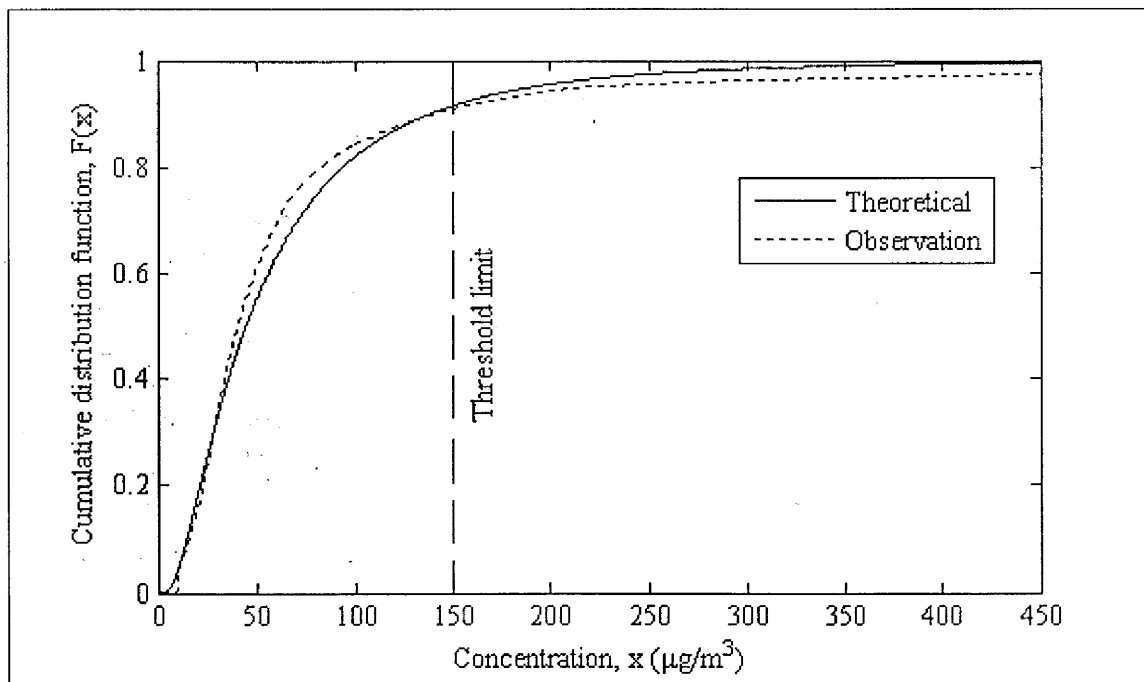
The probability distribution functions using Gamma distribution for Kuching



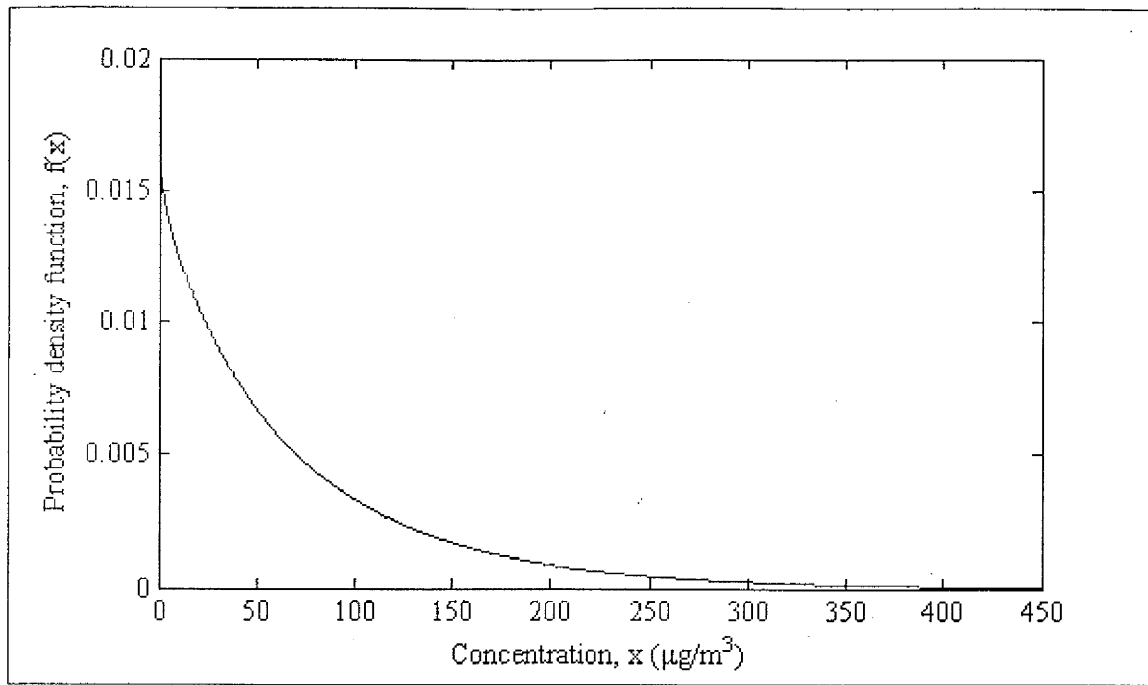
The cumulative distribution function plot using Gamma distribution for Kuching



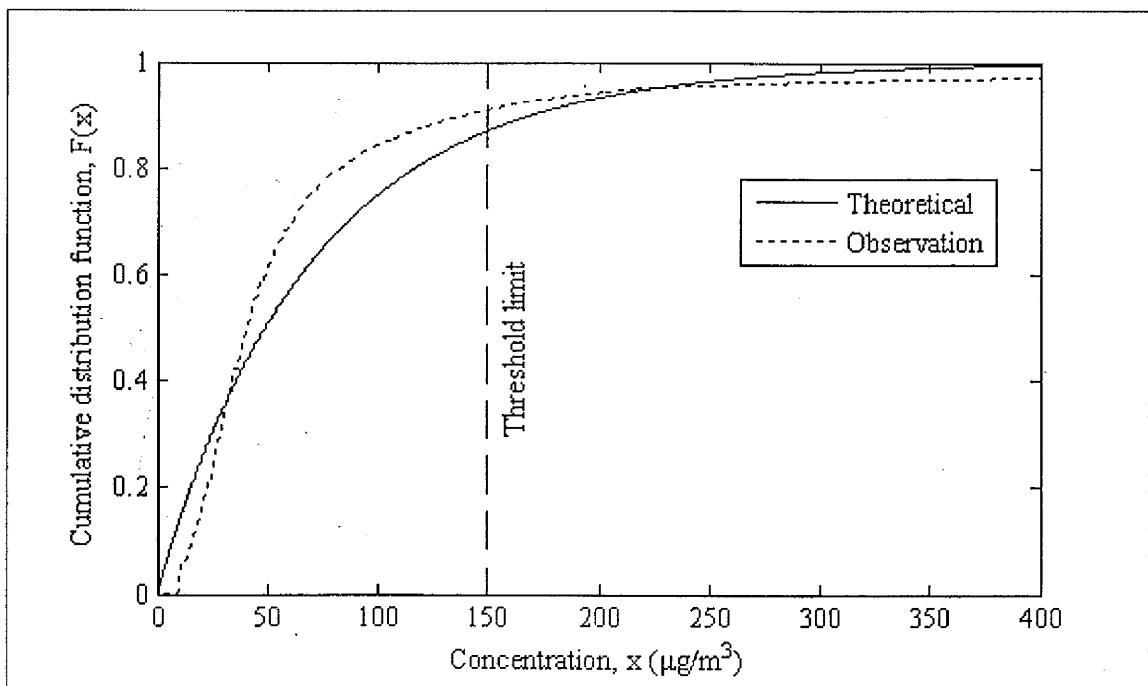
The probability distribution functions using Log-normal distribution for Kuching



The cumulative distribution function plot using Log-normal distribution for Kuching

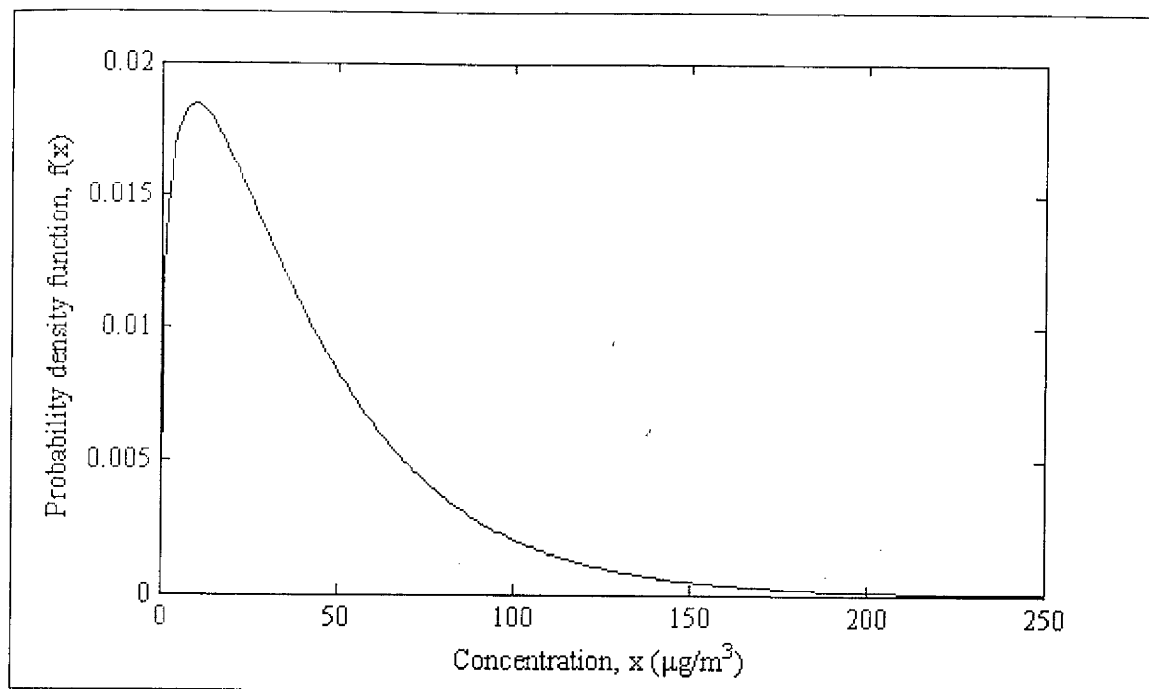


The probability distribution functions using Weibull distribution for Kuching

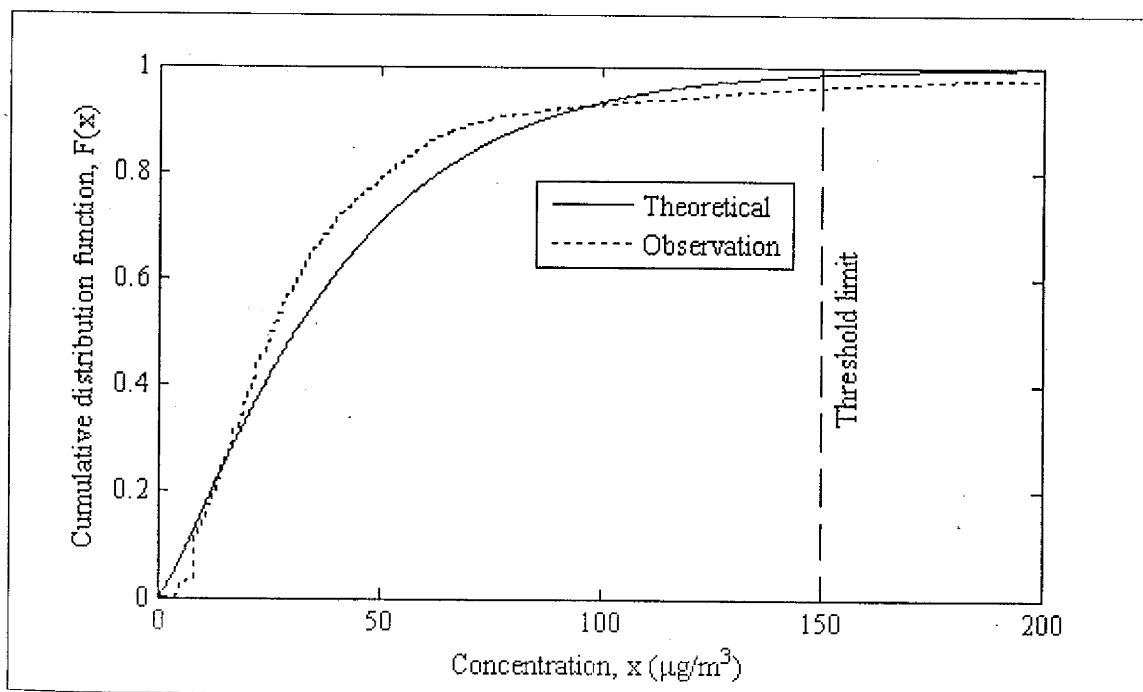


The cumulative distribution function plot using Weibull distribution for Kuching

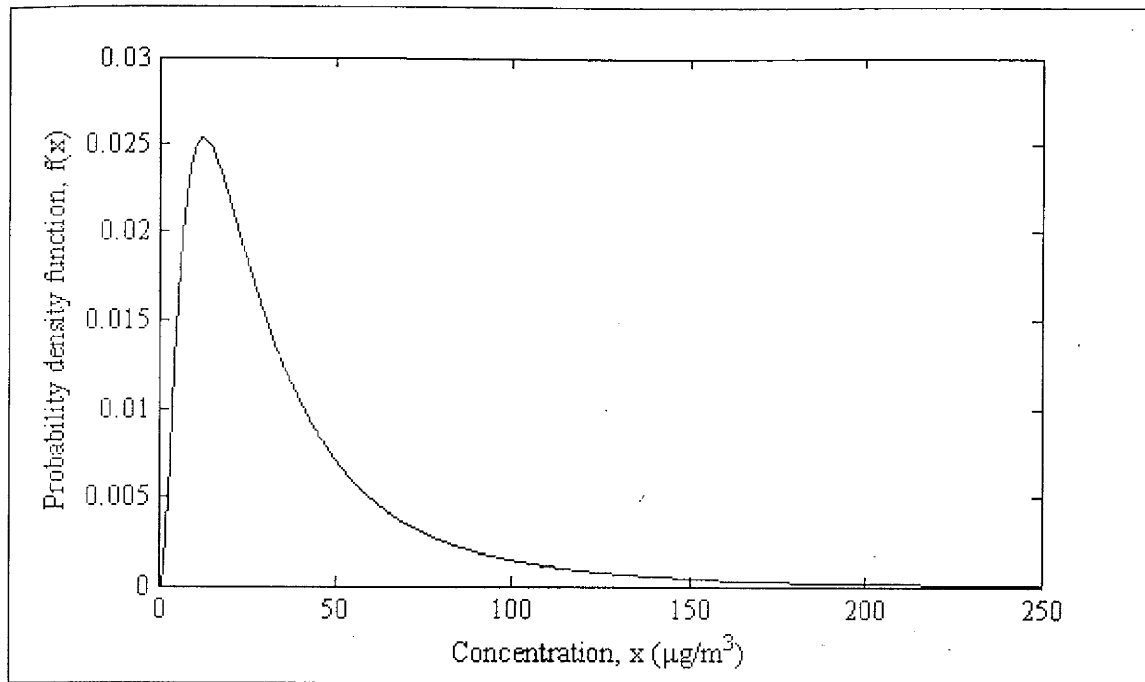
Jerantut



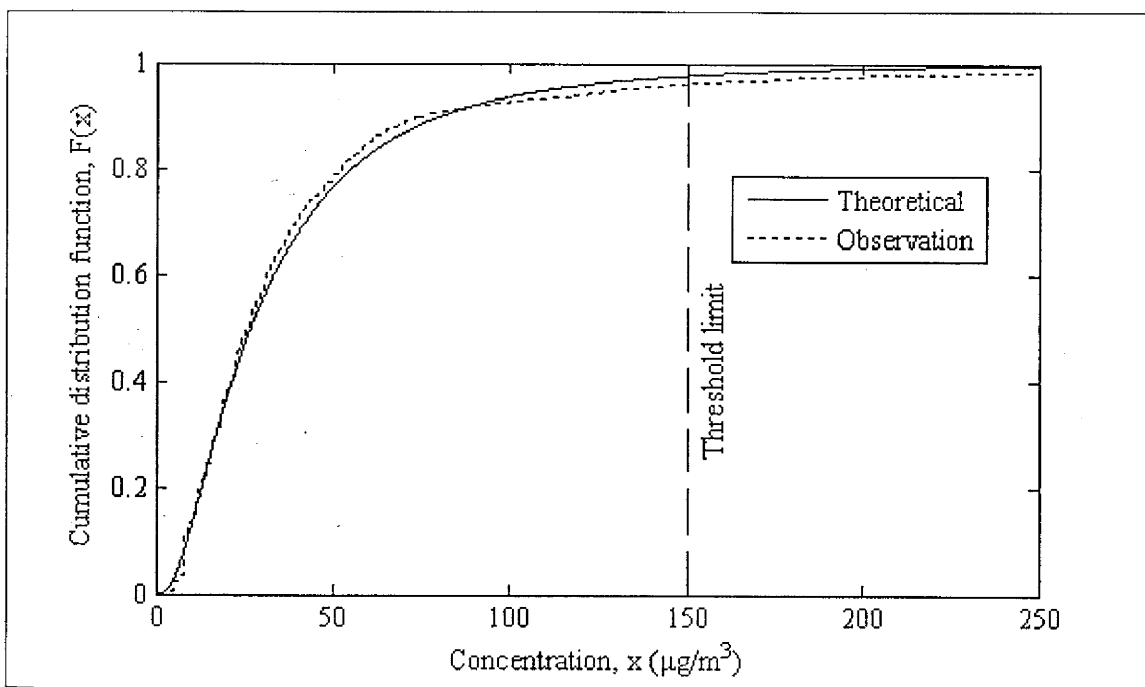
The probability distribution functions using Gamma distribution for Jerantut



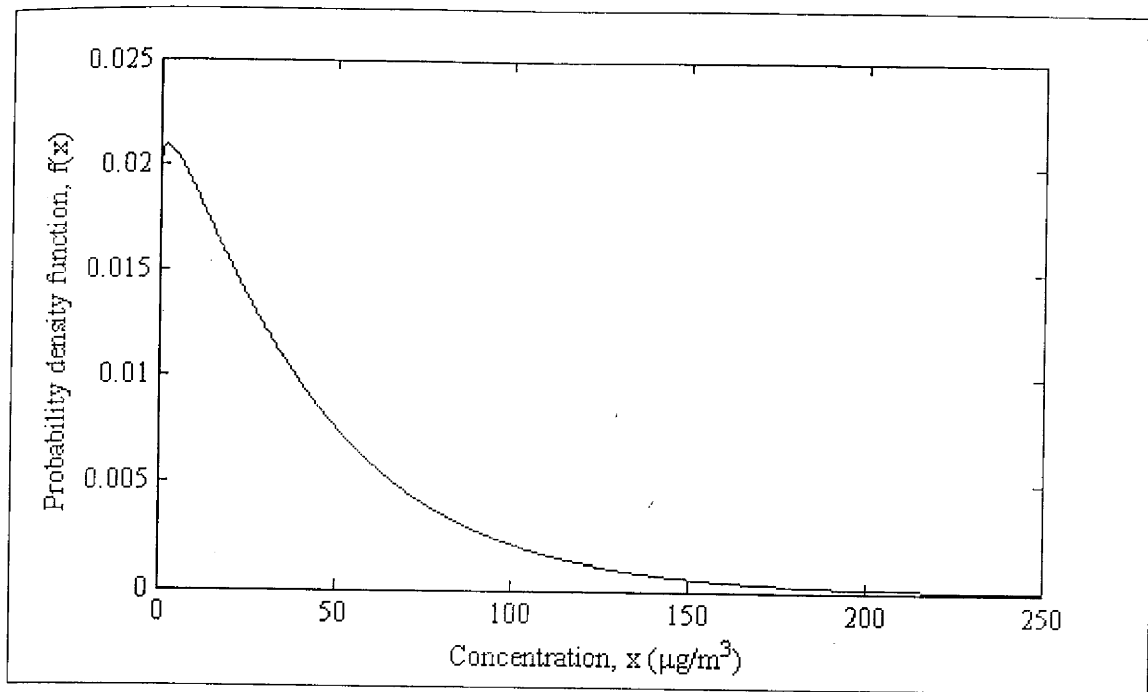
The cumulative distribution function plot using Gamma distribution for Jerantut



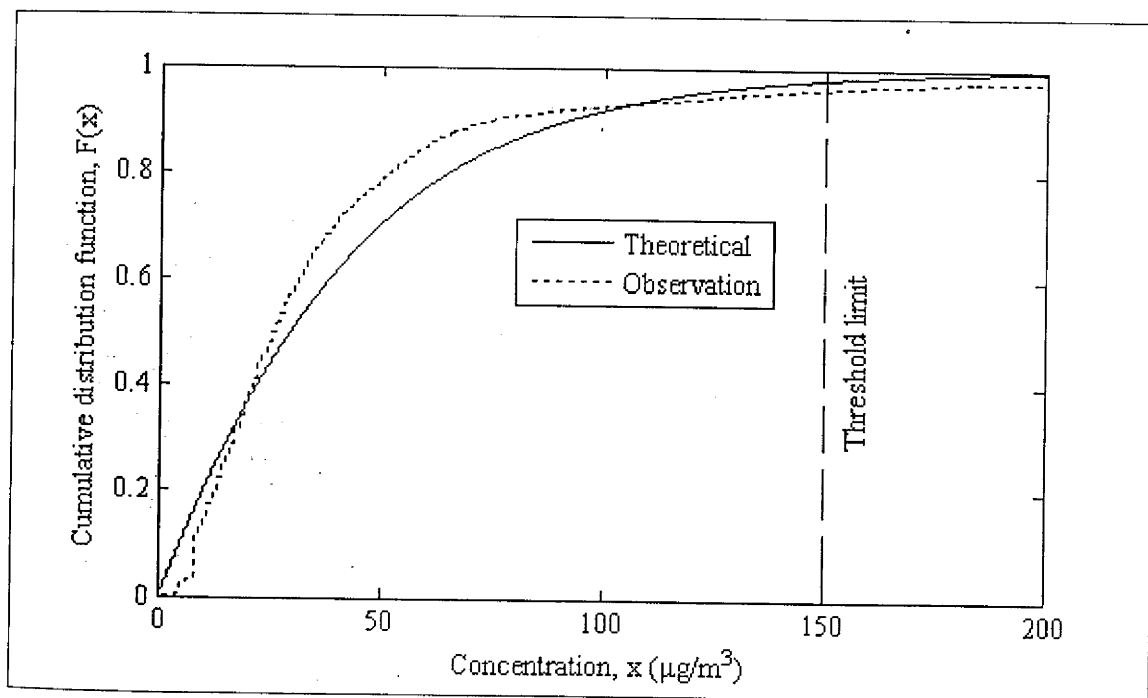
The probability distribution functions using Log-normal distribution for Jerantut



The cumulative distribution function plot using Log-normal distribution for Jerantut

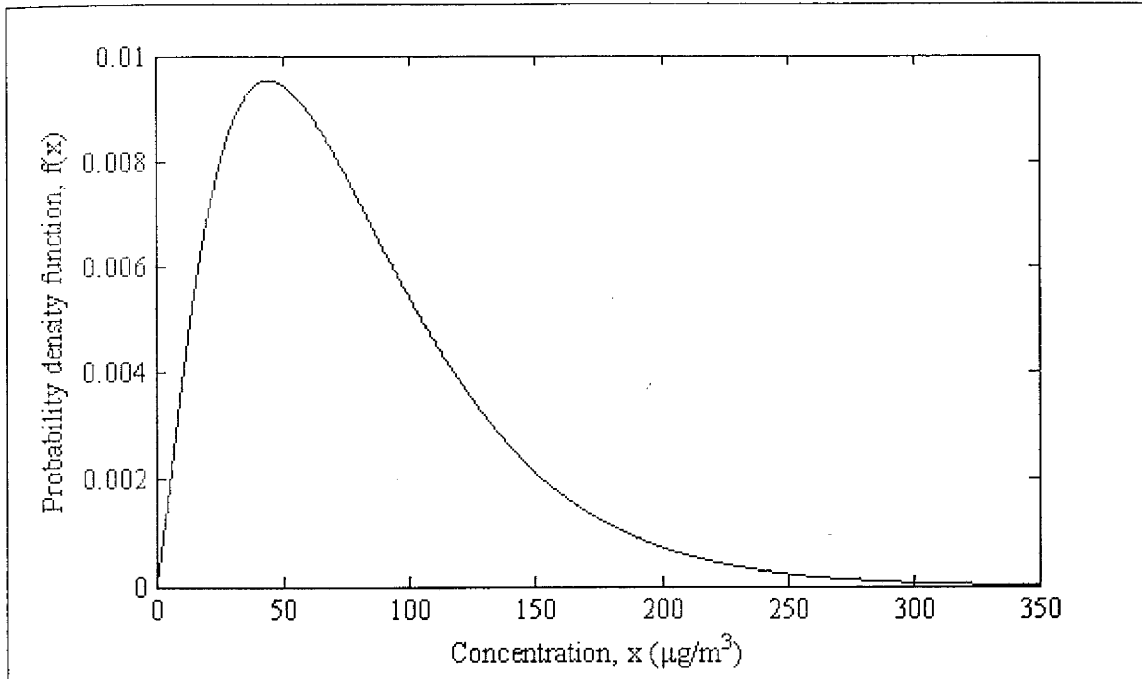


The probability distribution functions using Weibull distribution for Jerantut

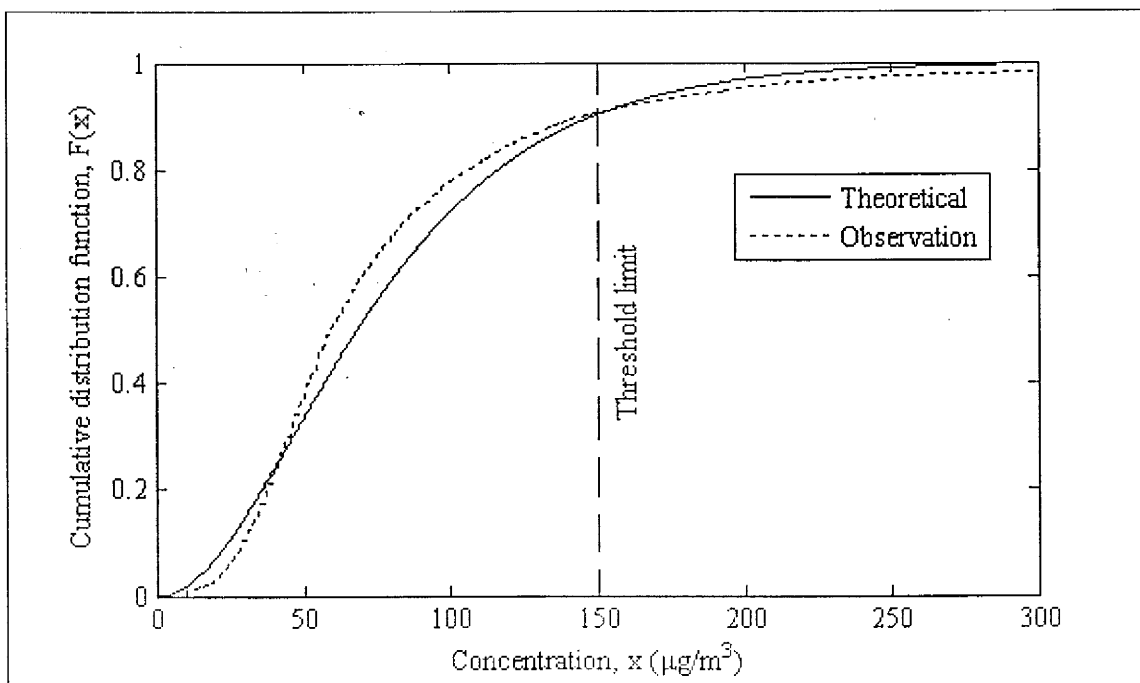


The cumulative distribution function plot using Weibull distribution for Jerantut

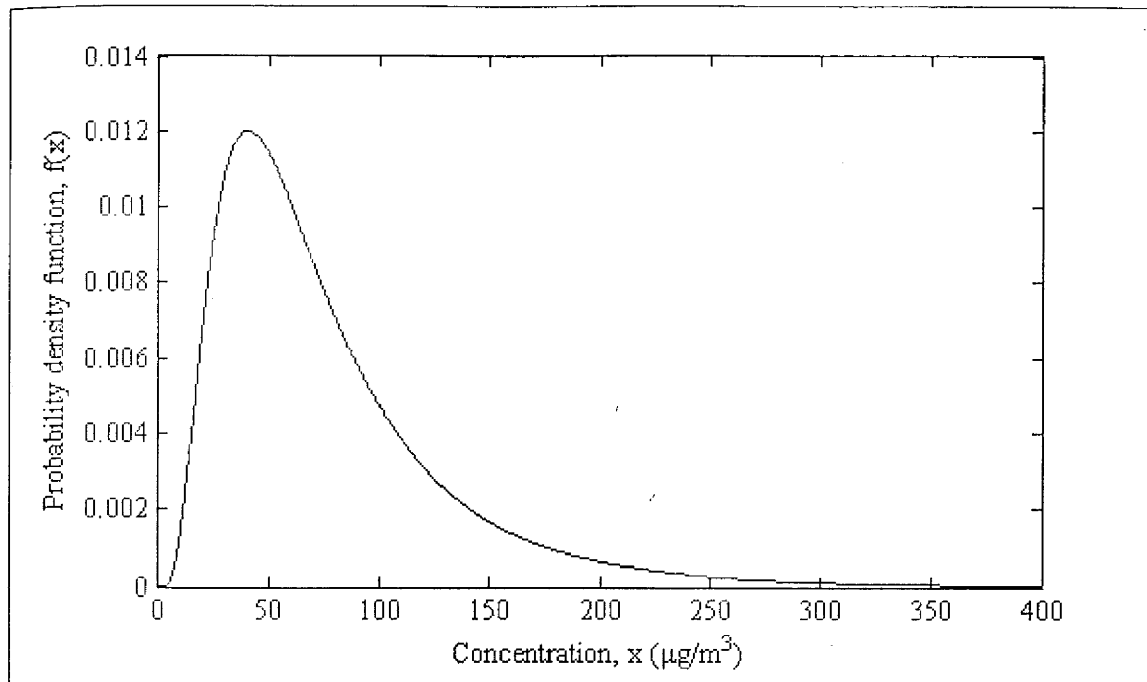
Nilai



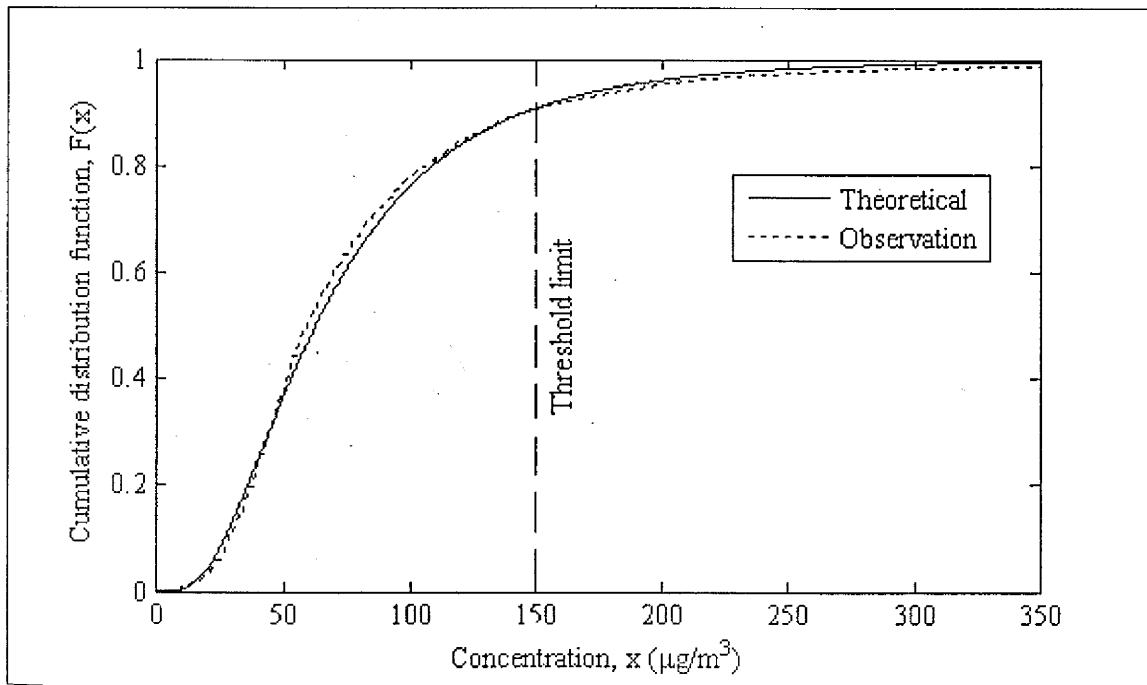
The probability distribution functions using Gamma distribution for Nilai



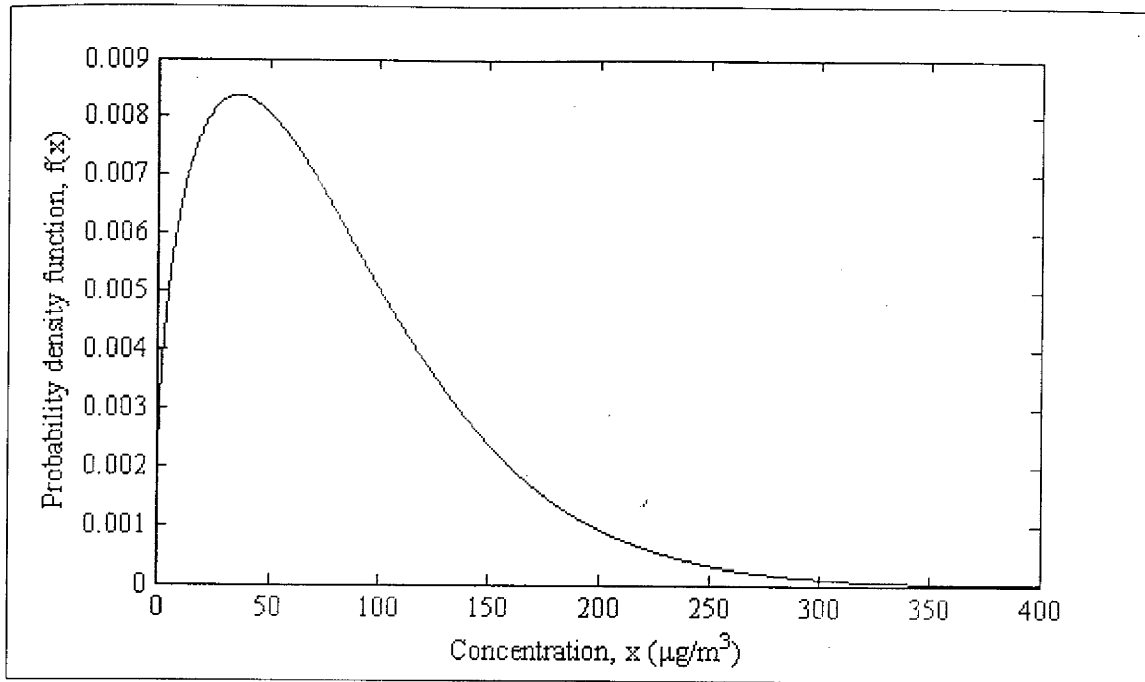
The cumulative distribution function plot using Gamma distribution for Nilai



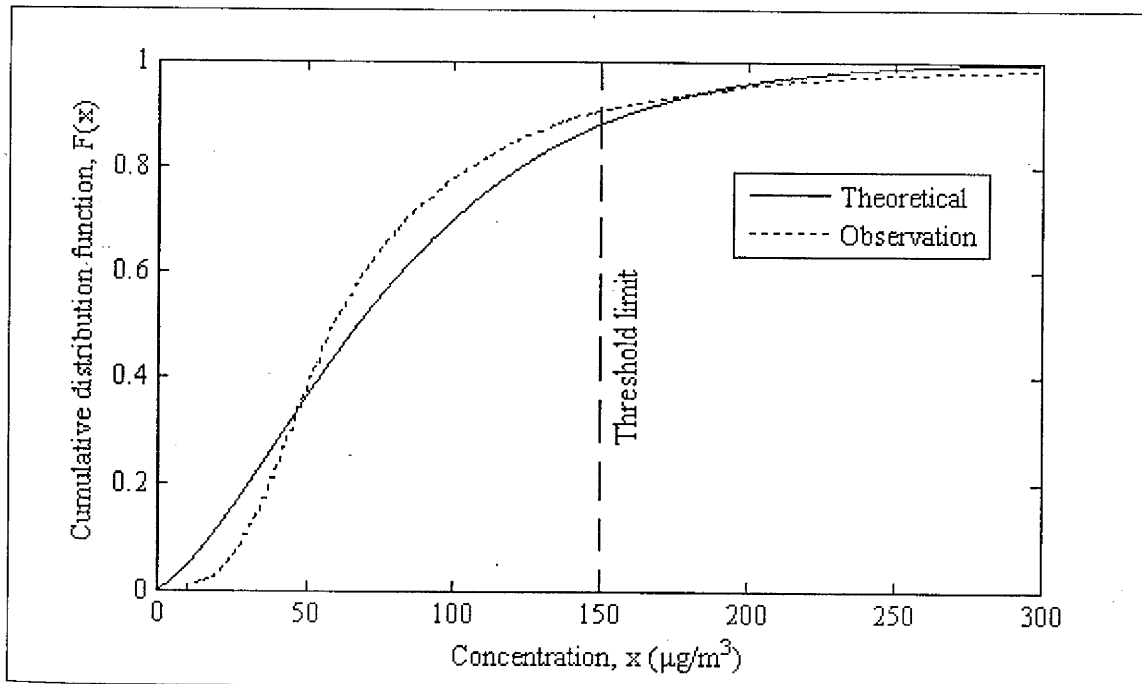
The probability distribution functions using Log-normal distribution for Nilai



The cumulative distribution function plot using Log-normal distribution for Nilai

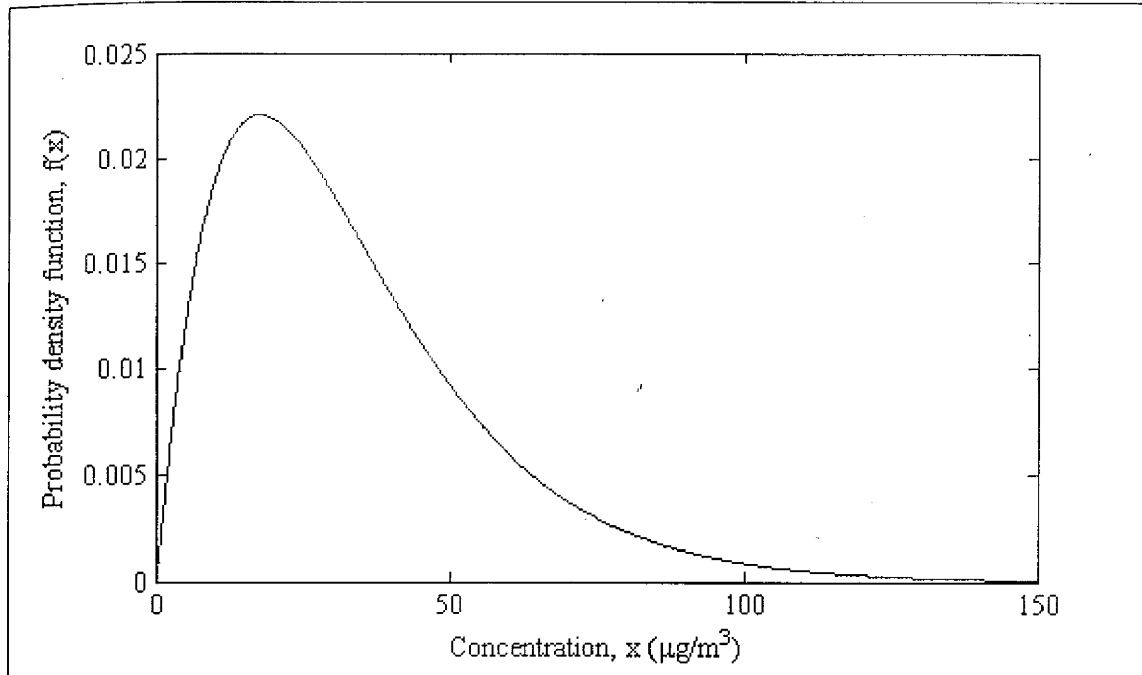


The probability distribution functions using Weibull distribution for Nilai

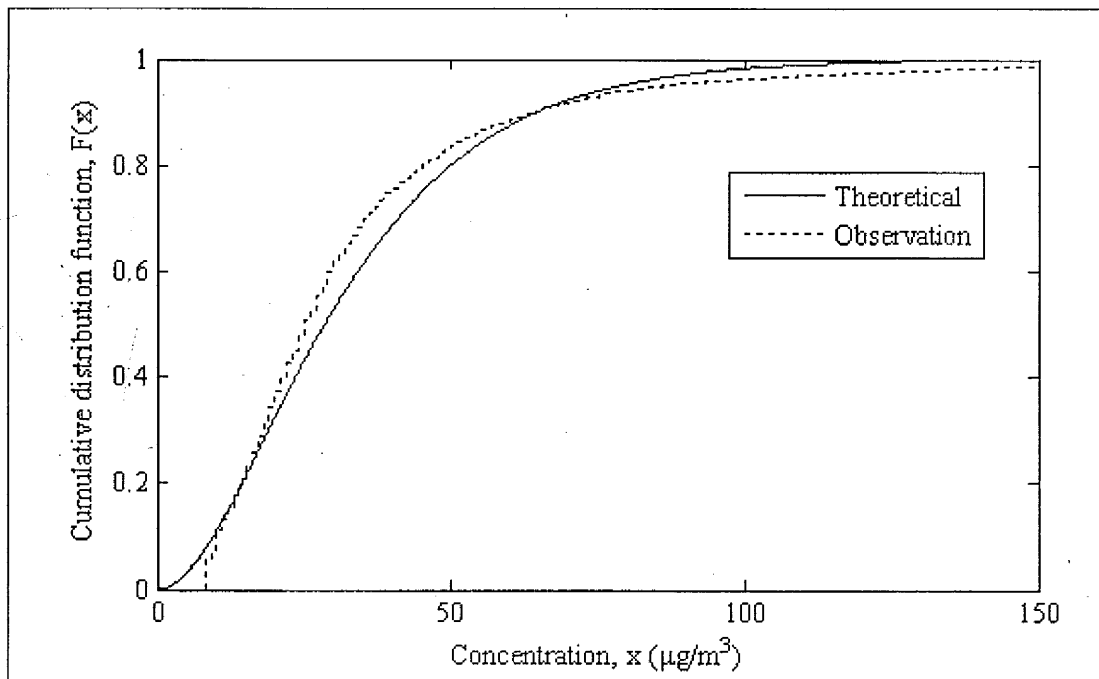


The cumulative distribution function plot using Weibull distribution for Nilai

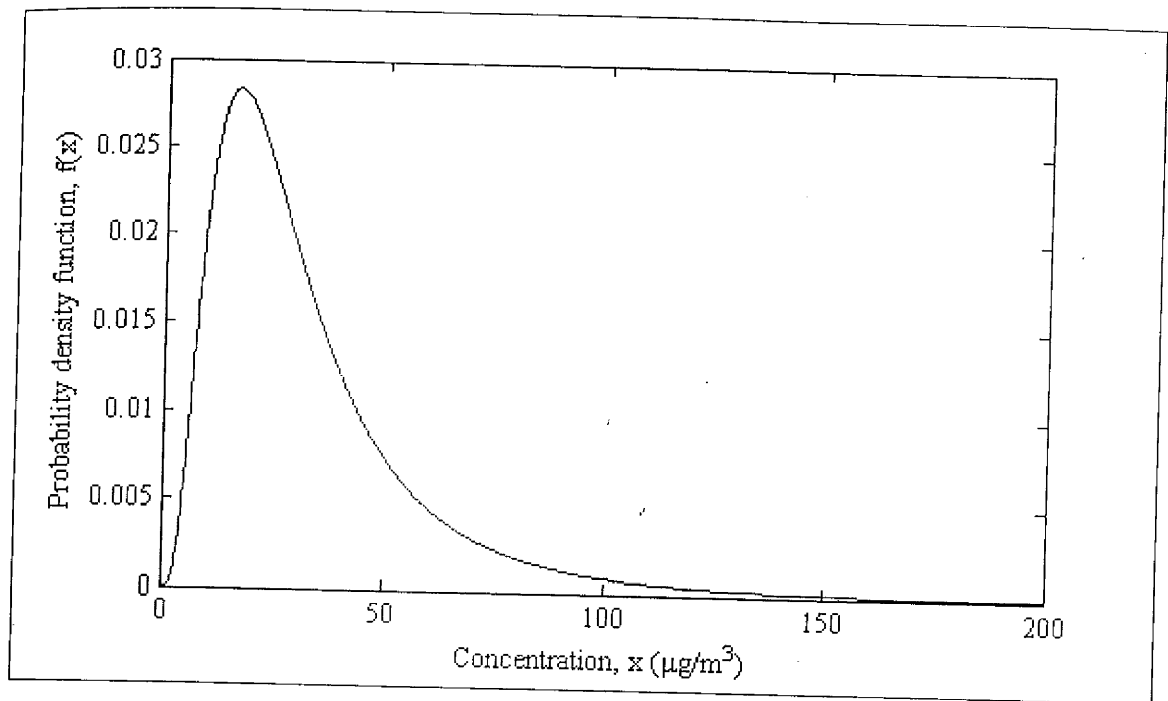
Indera Mahkota



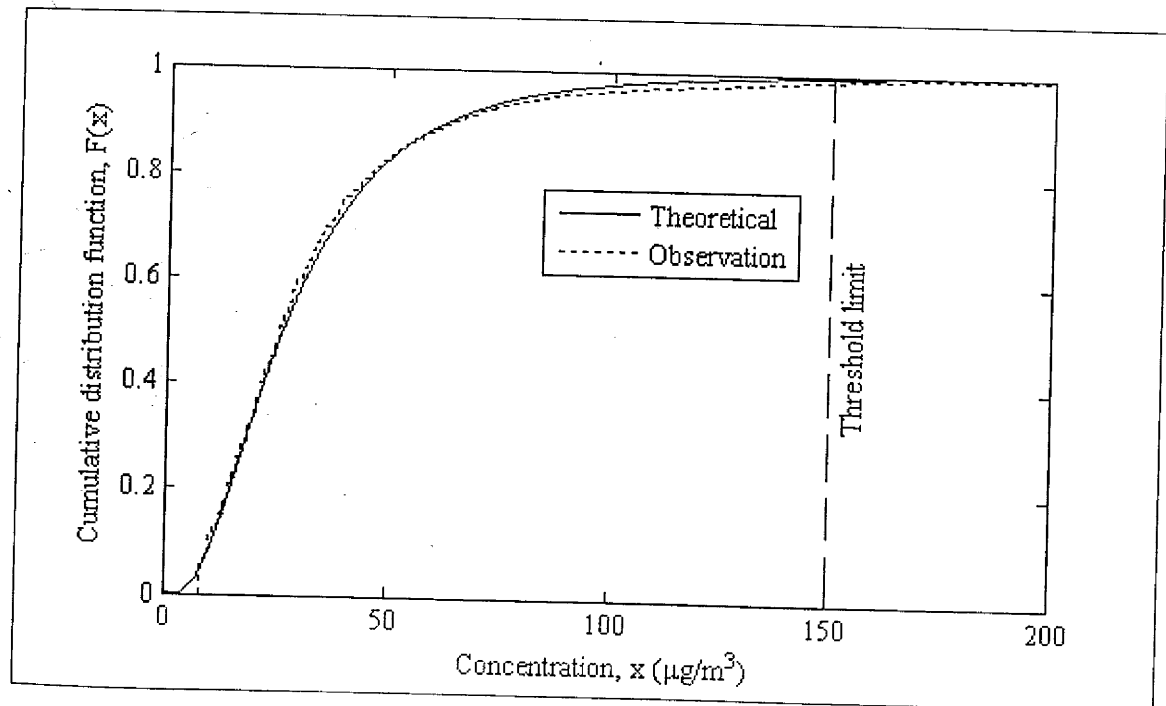
The probability distribution functions using Gamma distribution for Indera Mahkota



The cumulative distribution function plot using Gamma distribution for Indera Mahkota

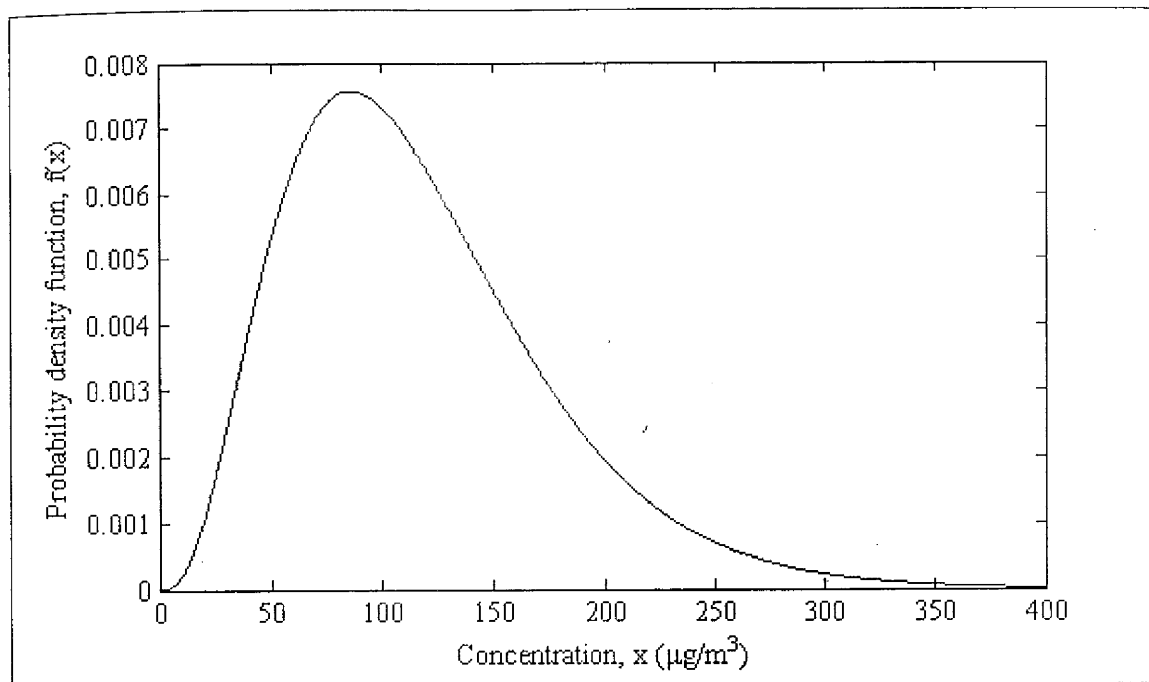


The probability distribution functions using Log-normal distribution for Indera Mahkota

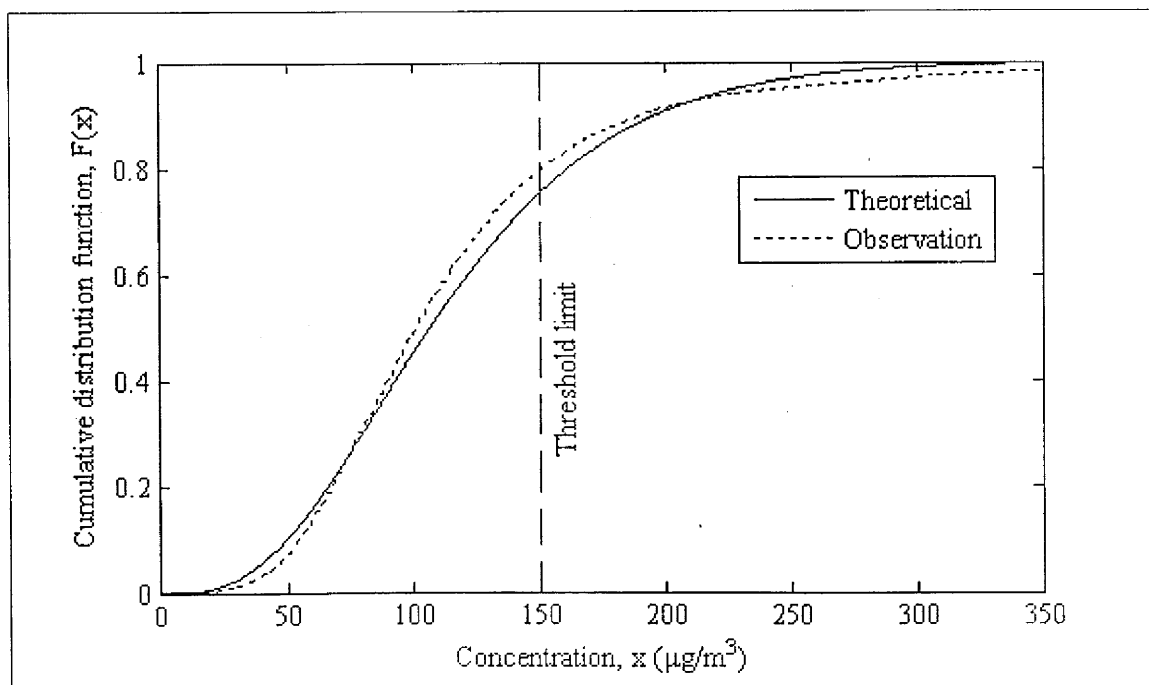


The cumulative distribution function plot using Log-normal distribution for Indera Mahkota

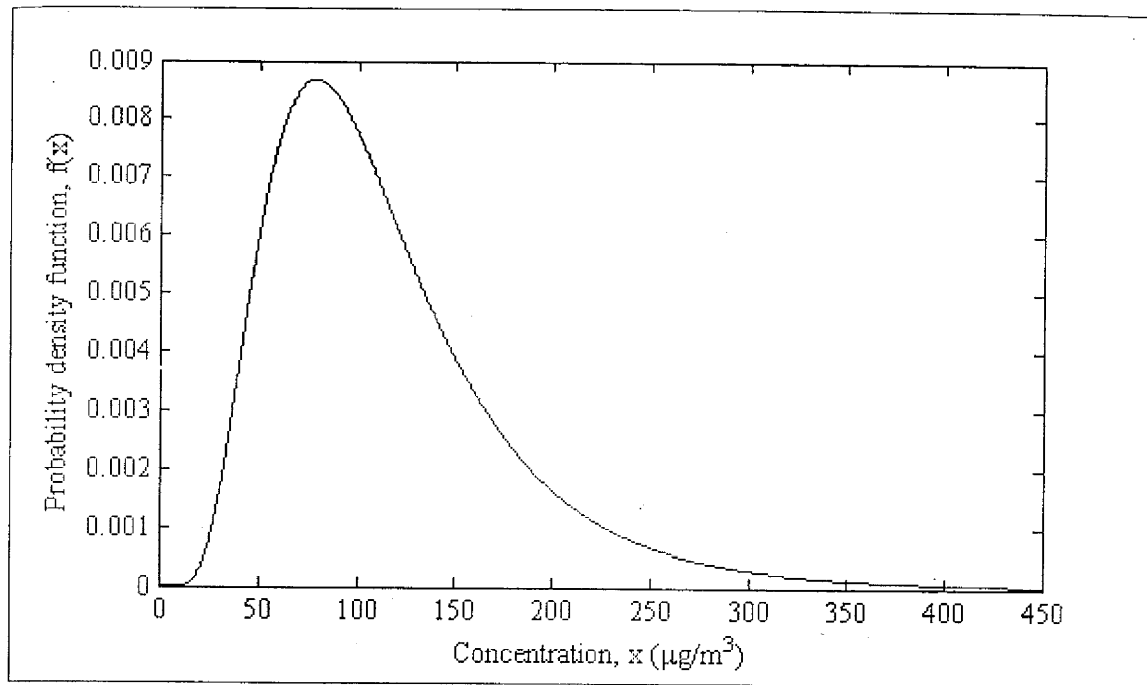
Kuala Lumpur



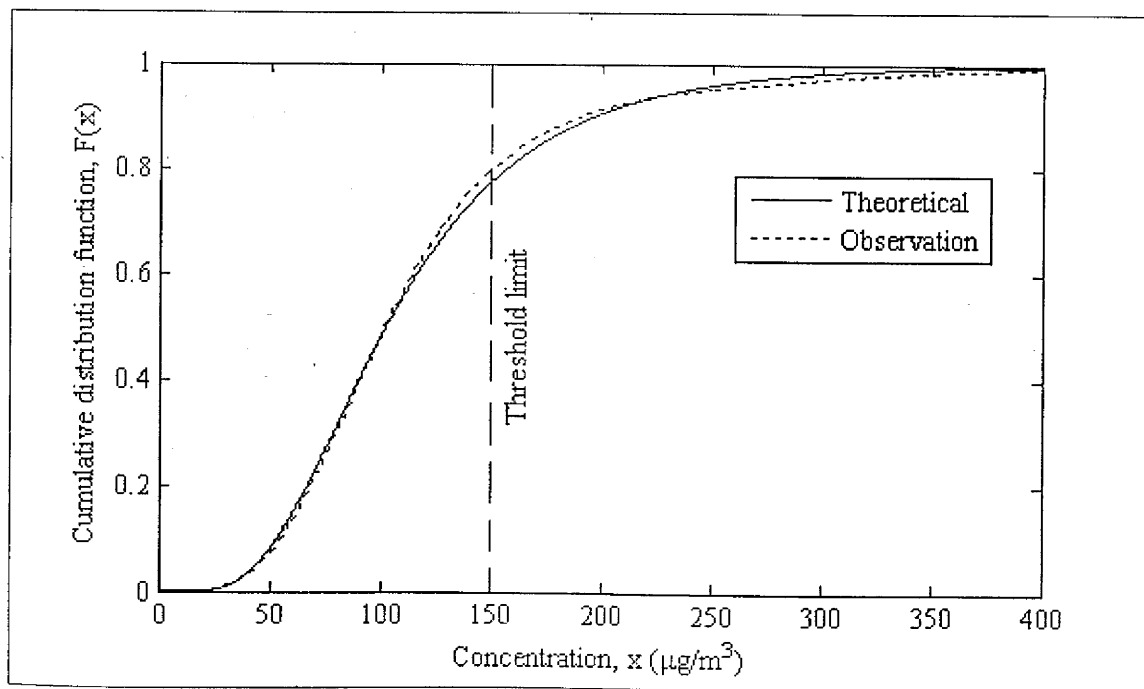
The probability distribution functions using Gamma distribution for Kuala Lumpur



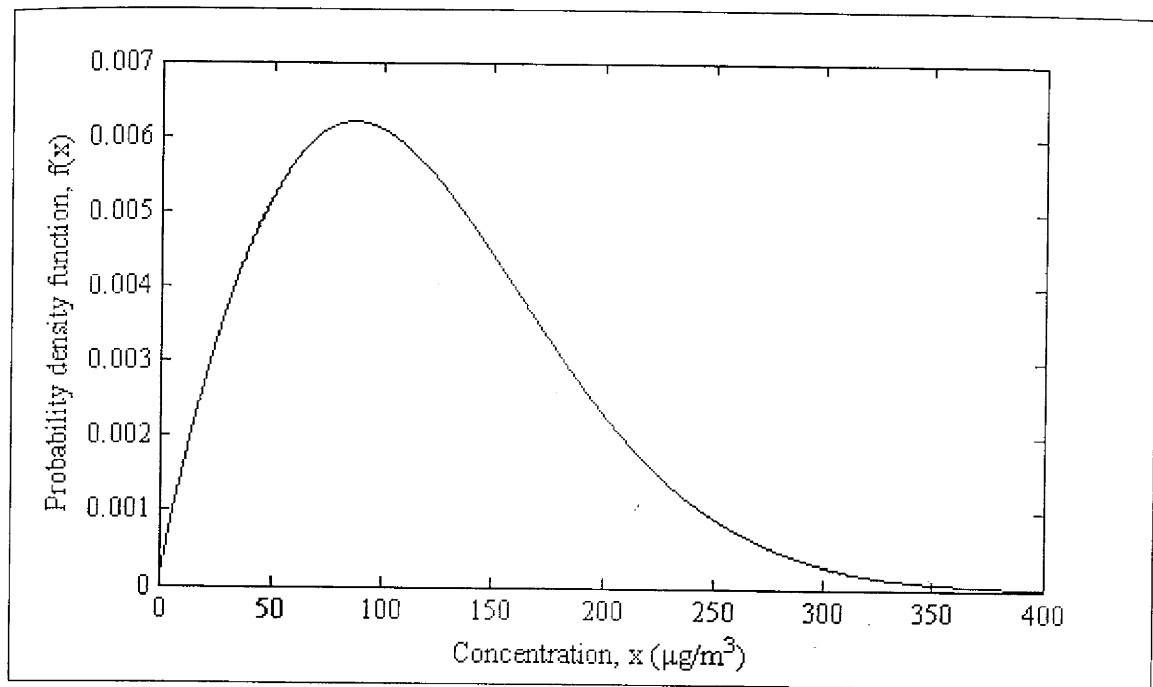
The cumulative distribution function plot using Gamma distribution for Kuala Lumpur



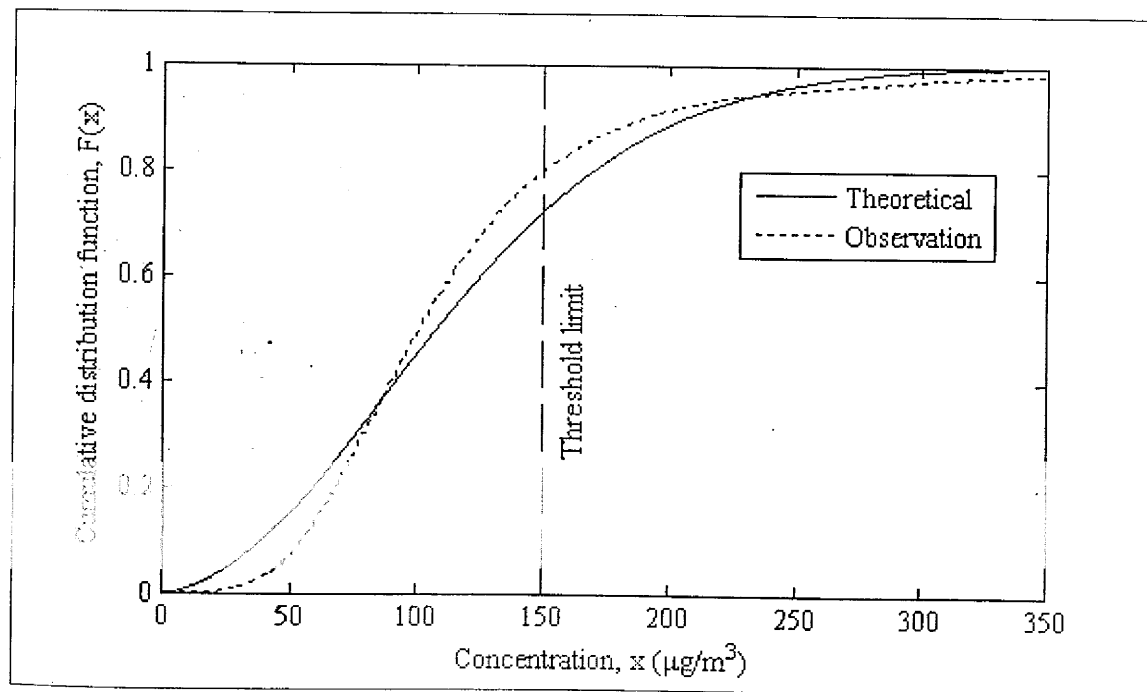
The probability distribution functions using Log-normal distribution for Kuala Lumpur



The cumulative distribution function plot using Log-normal distribution for Kuala Lumpur



The probability distribution functions using Weibull distribution for Kuala Lumpur



The cumulative distribution function plot using Weibull distribution for Kuala Lumpur

DESCRIPTIVE STATISTICS (2004)

	Perai	Kuching	Jerantut	Nilai	Indera Mahkota	Kuala Lumpur
Total, N	8580	8733	8449	8784	8632	7324
Minimum	5	5	5	5	5	5
Maximum	421	259	205	406	207	208
Mean	91.87	43.83	44.54	59.75	35.00	68.54
Variance	>1000	559.85	400.74	899.68	298.68	781.00
Std dev	38.17	23.66	20.02	30.05	17.28	27.95
Median	87	39	41	54	32	66
Skewness	0.76	2.22	1.29	1.34	2.24	0.63
Kurtosis	4.77	11.07	6.35	4.95	15.35	3.73

PARAMETERS VALUES (2004)

1. GAMMA DISTRIBUTION

	Perai	Kuching	Jerantut	Nilai	Indera Mahkota	Kuala Lumpur
σ (scale)	4.9981	4.3414	5.1754	4.2128	4.7624	5.6016
λ (shape)	18.3804	10.0967	8.6052	14.3841	7.3486	12.2360

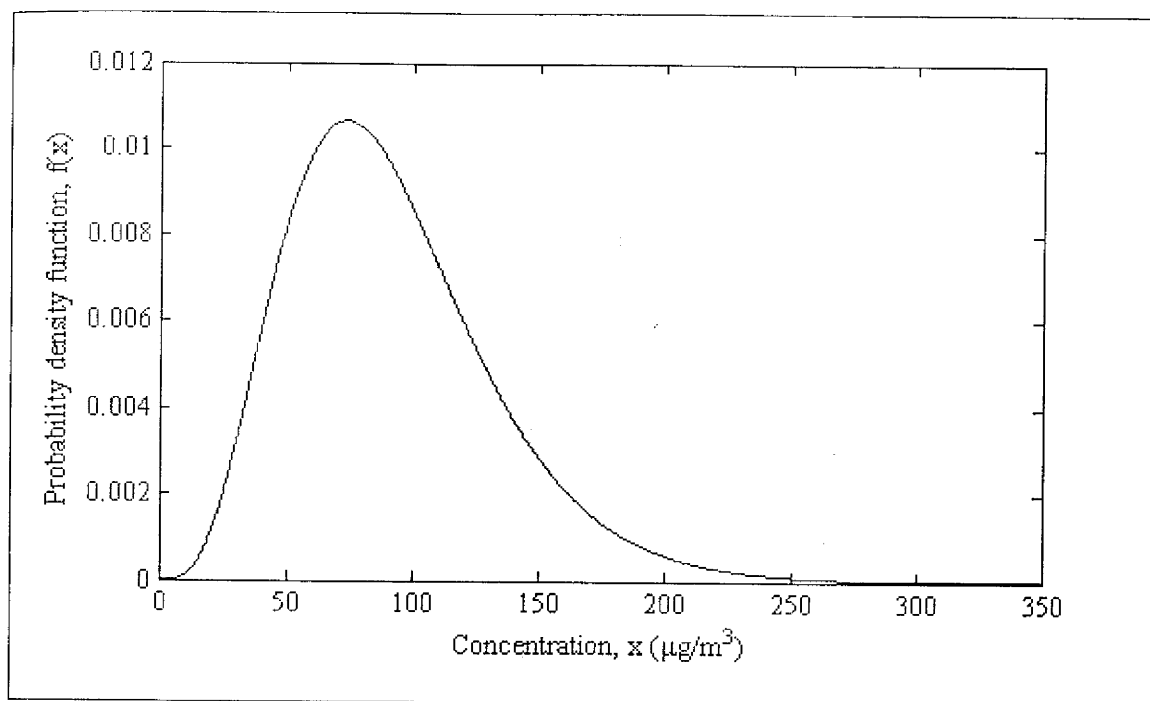
2. LOG-NORMAL DISTRIBUTION

	Perai	Kuching	Jerantut	Nilai	Indera Mahkota	Kuala Lumpur
μ (location)	4.4170	3.6608	3.6966	3.9809	3.4466	4.1355
σ (scale)	0.5064	0.4880	0.4618	0.5164	0.4744	0.4521

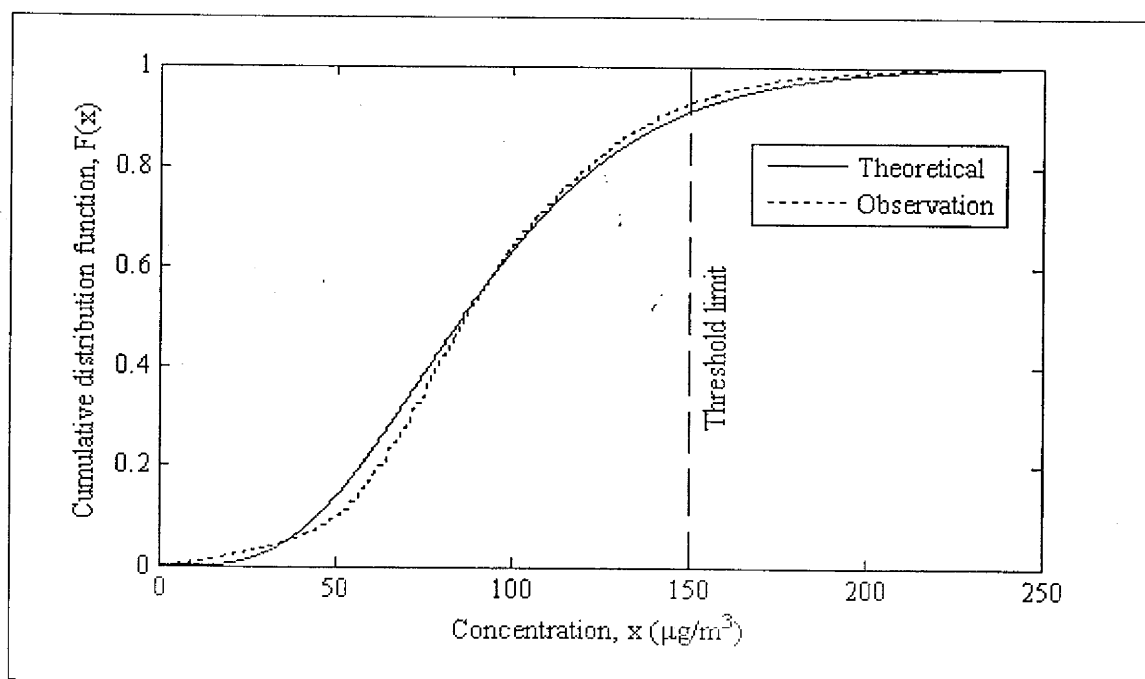
3. WEIBULL DISTRIBUTION

	Perai	Kuching	Jerantut	Nilai	Indera Mahkota	Kuala Lumpur
σ (scale)	103.24	49.63	50.29	68.55	39.53	77.17
λ (shape)	2.51	1.97	2.33	2.13	2.11	2.61

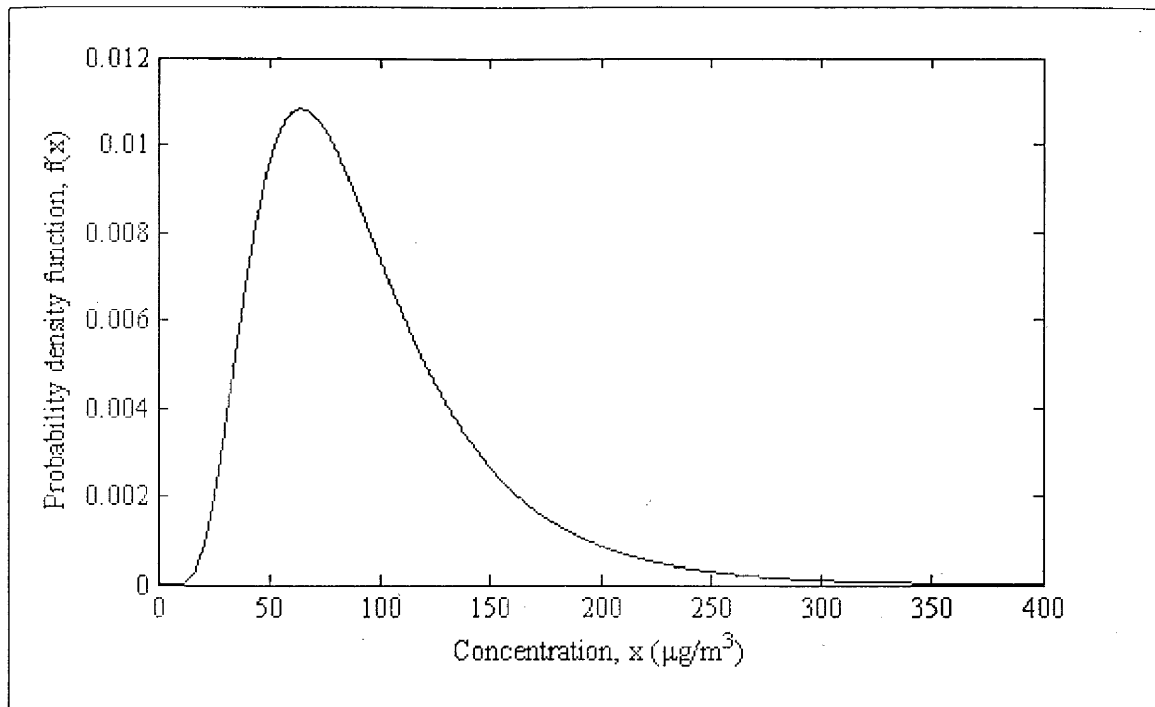
Peraí



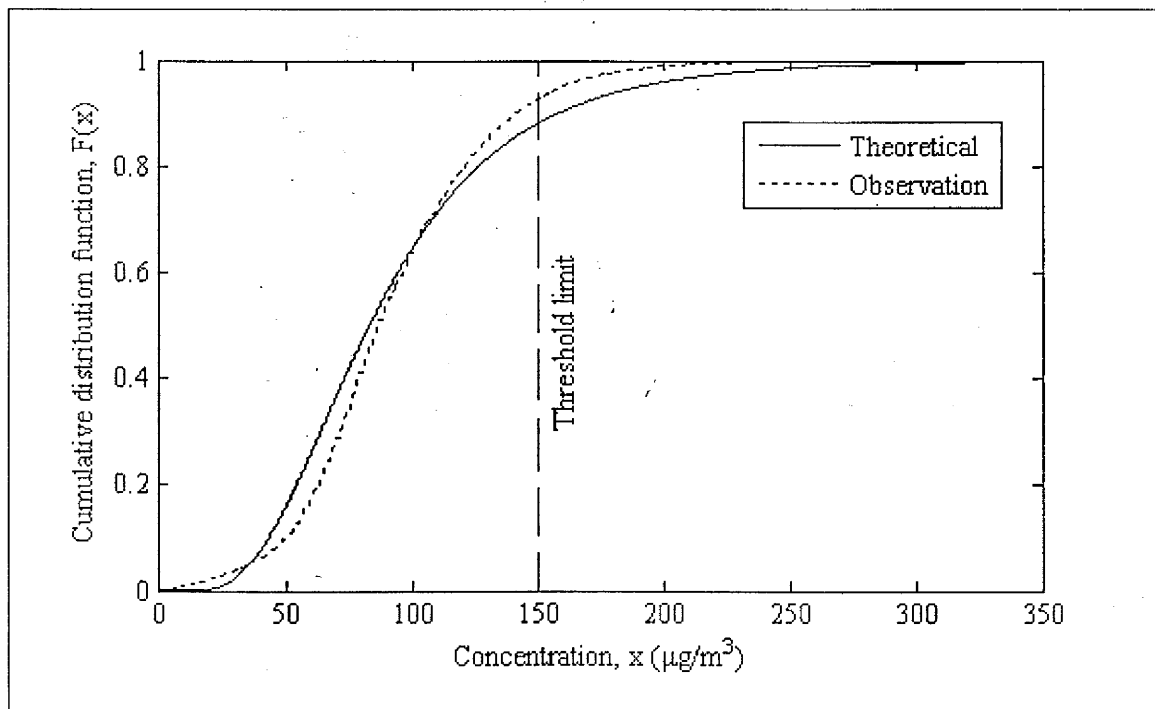
The probability distribution function plot using of Gamma distribution for Peraí



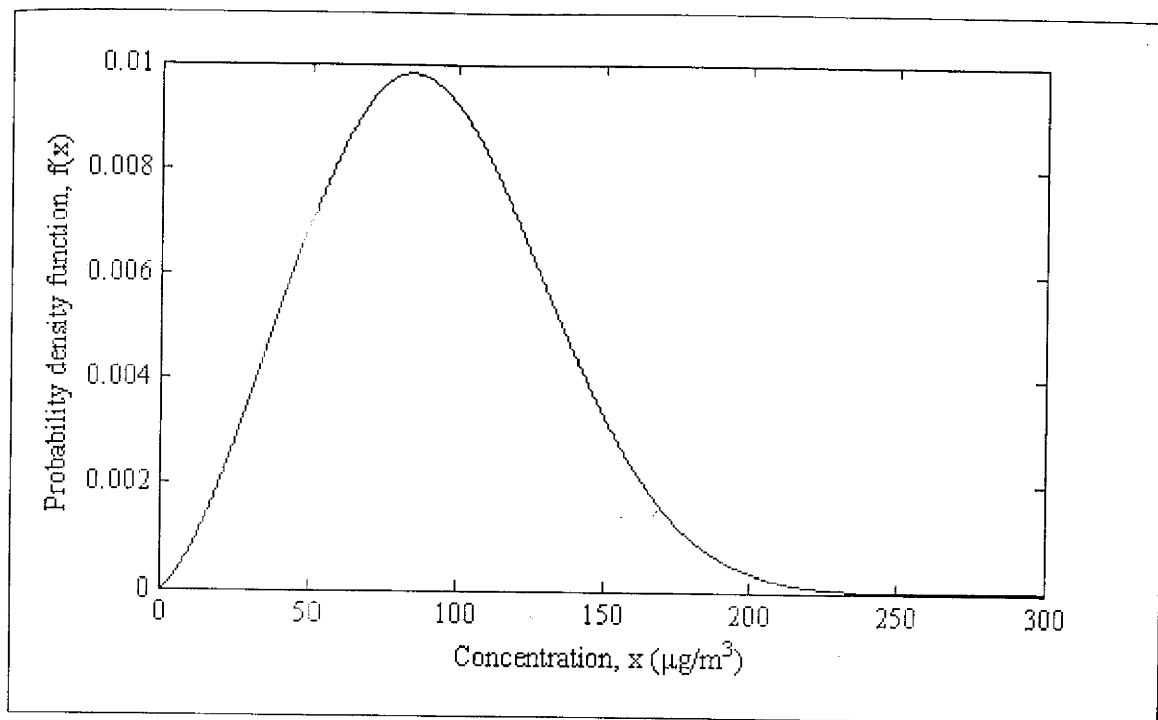
The cumulative distribution function plot using Gamma distribution for Peraí



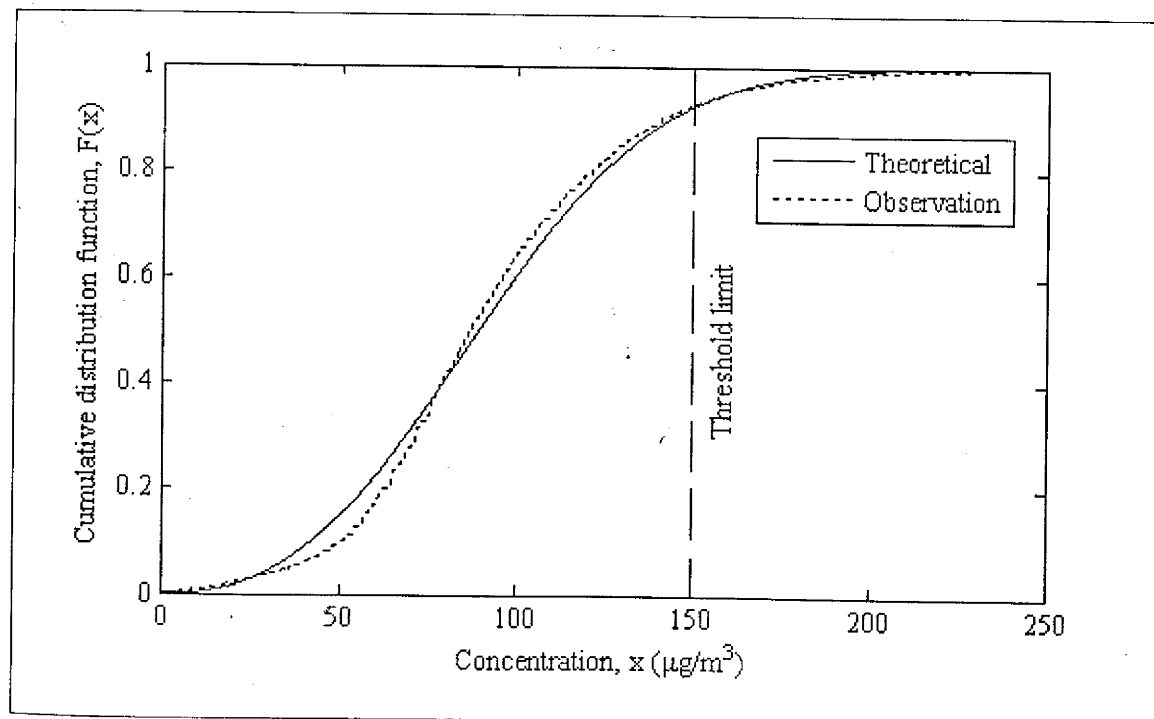
The probability distribution functions using Log-normal distribution for Perai



The cumulative distribution function plot using Log-normal distribution for Perai

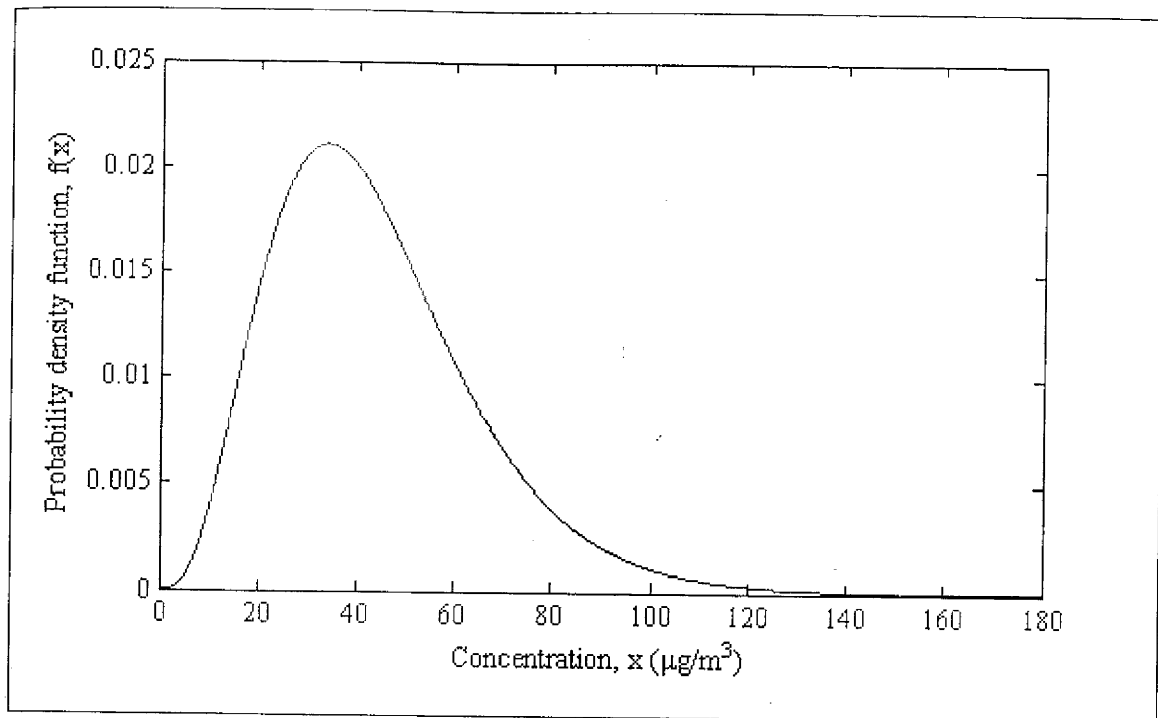


The probability distribution functions using Weibull distribution for Perai

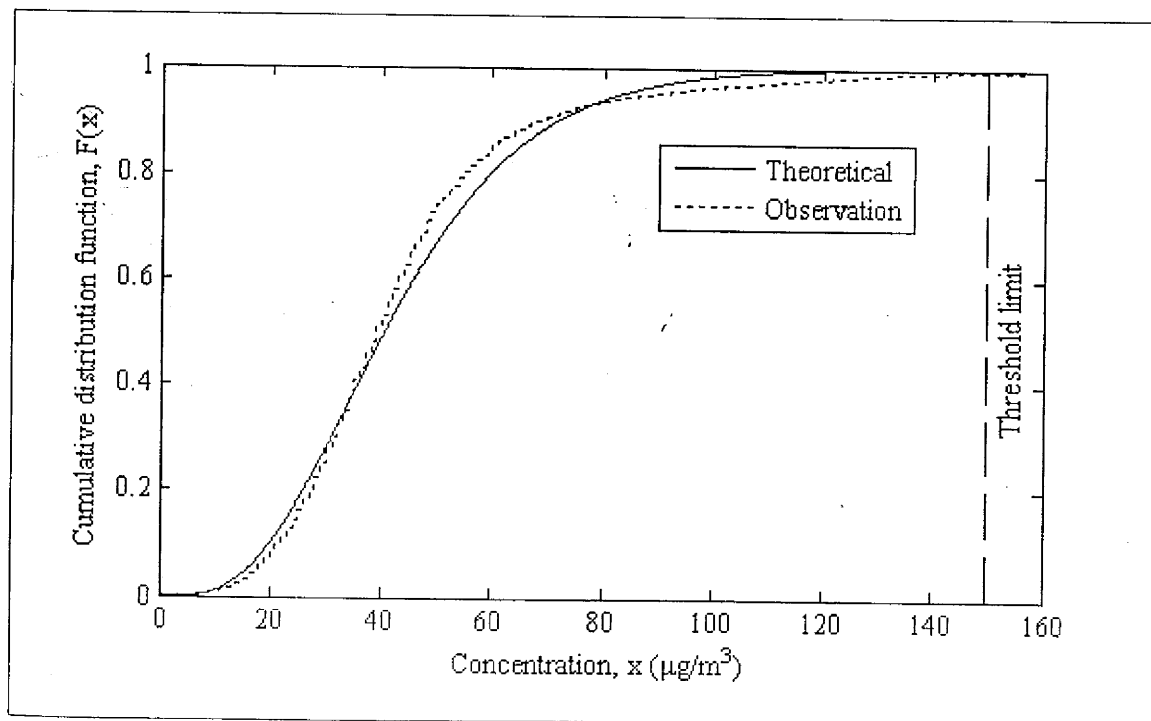


The cumulative distribution function plot using Weibull distribution for Perai

Kuching



The probability distribution functions using Gamma distribution for Kuching



The cumulative distribution function plot using Gamma distribution for Kuching